Spectra of Zeta Aurigae

...r Eclipse Observations

...Tales

...and Southern
...r Charts

Planetarium Notes

ADLER PLANETARIUM

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August: THE END OF THE WORLD.

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July: SUNSPOTS AND NORTHERN LIGHTS. As this is a period of maximum solar activity, magnetic and radio disturbances and aurorae should be more numerous and more severe. They will be discussed this month.

August: ROMANCE OF SUMMER SKIES.

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July: TRIP TO THE MOON. This always exciting extravaganza will be offered with new thrills that should interest everyone.

August: TRIP TO THE MOON.

Sky and TELESCOPE

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CHARLES A. FEDERER, JR., *Editor;* HELEN S. FEDERER, *Managing Editor*

In Focus

SPECTRA such as those on the front cover are studied in detail by astronomers to determine the characteristics of the stars. In this case, these University of Michigan spectra reveal the changes in the eclipsing binary Zeta Aurigae, both for the pre-eclipse period in December, 1947, and for the emergence late in January.

The sketches on the right show the edge of the **K** star, with the dotted area representing roughly its atmosphere. The **B** star is a small round circle which moves relatively to the left, half eclipsed on December 14th. The sequence of events and spectral changes is described by Dr. McLaughlin in his article beginning on page 219. The lines produced by various elements are labeled at the bottom; these apply to the dark absorption lines in the stellar spectra and not to the bright reference lines which are from laboratory sources to furnish wave length standardization on each spectrum.

Commencing near the hydrogen-delta line at 4101.75 angstroms, the spectra extend into the ultraviolet. The top strip, for November 11, 1947, shows the normal composite spectrum of Zeta Aurigae. By its pre-eclipse position **behind** the **K** star's atmosphere, the **B** star acts as a source of light at wave lengths where the **K** star is itself deficient in intensity, thus revealing many of the characteristics of the **K** spectrum in the violet and ultraviolet, especially in the spectrograms of December 11th to 14th. Note how, during total eclipse, the **B** star's contribution is removed, leaving a **K** spectrum which falls off rapidly in intensity at about the hydrogen-epsilon line.

Lines for the various elements labeled in the picture can probably best be found in the following spectra, from left to right: titanium II, Dec. 9, 11, Jan. 23, 25; hydrogen iota (and other **narrow** lines of Balmer series, belonging to the **K** star), Dec. 9, 11, Jan. 23, 25; iron, Dec. 11, 13, Jan. 22, 23; titanium II, Dec. 13, 14, Jan. 22, 23; calcium II (K and H lines), narrow in Dec. 9, 11, Jan. 23, et seq, but very broad Dec. 14 and Jan. 21, showing density of calcium near **K** star's surface; also note typical H and K absorption of **K** star alone on Jan. 20; strontium II, Dec. 13, 14, Jan. 21, 22.

Russell W. Porter's drawing of the lower section of the 200-inch prime-focus

(Continued on page 229)

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An Eclipse Reveals a Giant Star's Atmosphere

By Dean B. McLaughlin, *University of Michigan Observatory*

ANOTHER ECLIPSE of Zeta Aurigae has come and gone. At some time before December 9, 1947, the news reached the earth (via light waves) that some 1,200 years ago a bluish hot star had begun to pass behind the extensive atmosphere of its companion, a relatively cool star. And on the night of December 14th, the record (still 1,200 years old, of course) showed that the eclipse of the small hot star by the disk of the large cool one was approaching totality. Then for five weeks the only light that came from that system was from the giant star alone, while its companion was passing behind its huge diameter. On January 21, 1948, during the daylight hours in the Western Hemisphere, the emergence from total eclipse began, and for the next several days the spectrum went through remarkable changes as the small star shone first through the deeper, denser layers and finally through the topmost rarefied layers of the gaseous envelope that surrounds its giant companion.

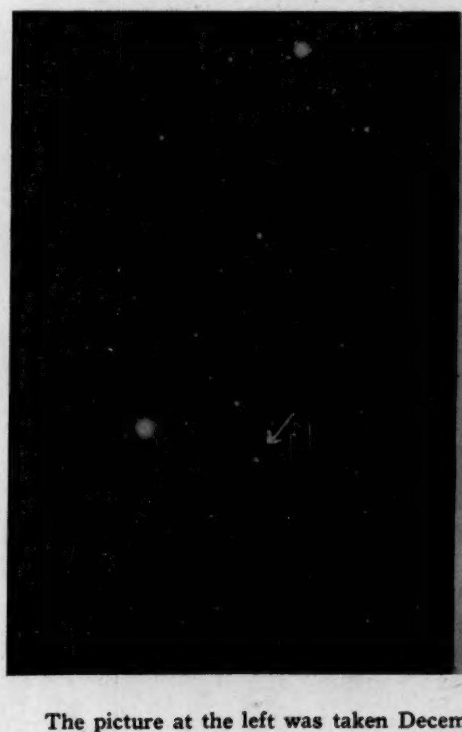
If an astronomer of a century ago had been asked whether we might ever hope to know the true dimensions of stars, it is quite possible he would have snorted: "Of course not!" The most tolerant answer might have been expressed somewhat as follows: "Henderson has measured the parallax of Alpha Centauri and Bessel has measured that of 61 Cygni. We have no accurate comparison of the light of these stars with the sun, but we know that if either of them were in the sun's place it would appear *sunlike* in brilliance. We may conjecture that it would appear sunlike in size, but we cannot know actually how large the stars are." As for stellar atmospheres, who would have thought to ask about them? Astronomers were not yet sure whether the sun itself had an atmosphere; it was still a moot point whether the corona and prominences belonged to the sun or to the moon!

Less than half a century later the spectrograph had proven its usefulness in the measurement of radial velocities; spectroscopic binaries had been discovered, and the size of the orbit of the eclipsing star Algol had been determined from its measured orbital speed and its period of revolution. The duration of Algol's eclipses furnished a measure of the sizes of the stars as compared with the relative orbit of the pair. With a plausible assumption as to the ratio of masses of the two stars, their dimensions were calculated. Though the results in this first application were a little uncertain, the tools for doing the job were at hand, and true measurements of the dimensions of stars became a recognized possibility.

By the time another quarter-century had passed, determination of the sizes of stars had become commonplace. Many eclipsing binaries had given up the secret of their dimensions under determined attack by the spectrograph and the photometer, especially after H. N. Russell, of Princeton, devised a neat method of determining the relative sizes of the stars and their orbits from the light curve. The laws of radiation of light by hot bodies had been formulated by physicists, and had been applied by astronomers to the calculation of diameters of stars whose total brightness and temperature were known. If any doubting Thomases remained, they were probably convinced by the measurement of the diameter of the red giant Betelgeuse with the interferometer, a crucial observation that agreed with the value calculated from radiation theory. As interferometer measurements of Aldebaran, Arcturus, and Antares followed, proof was piled on proof. From that time on, radiation theory was one of the everyday tools of the astronomer.

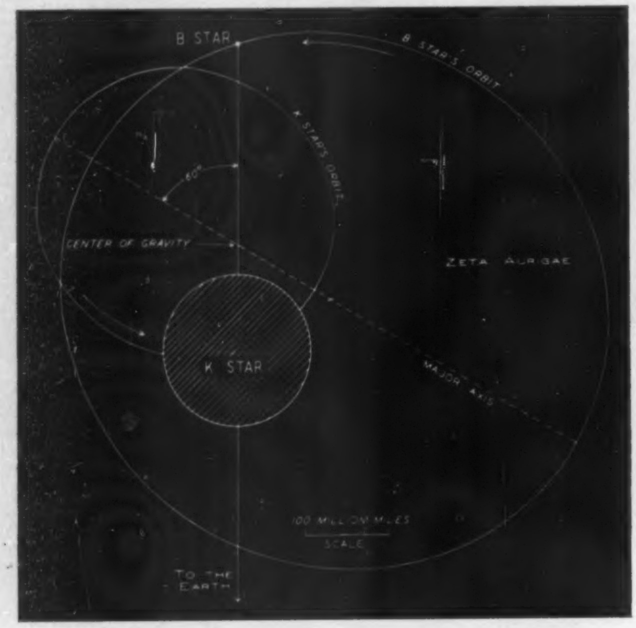
At the same time, a quarter-century ago, it is doubtful whether any astrophysicist would have been ready to admit that it was conceivable we should ever be able to determine in a conclusive way the structure of the atmosphere of any star other than the sun. Surely that would remain forever in the realm of speculation. At best, perhaps a plausible theory would be developed, but observational confirmation would be impossible. I recall especially the skepticism that greeted suggestions concerning extensive pulsating atmospheres about Cepheid variable stars. And all the time Zeta Aurigae was periodically winking off and on, every two and two-thirds years. The Harvard patrol cameras recorded several of these eclipses, but not until many years later was information about the light curve obtained by study of these photographs.

In the early work of classifying stellar spectra at Harvard, Miss Antonia C. Maury pointed out Zeta Aurigae as one of the most beautiful examples of "composite" spectra. Its spectrum combines that of a cool, strongly yellow star of class *K* with that of a hot, bluish star of class *B*. In the longer wave lengths, red, yellow, and even blue, the dominant light is that of the yellow star. But in the shorter wave lengths, violet and especially ultraviolet, the blue star gives most of the light. Thus, we see the numerous strong lines of the metals,



The picture at the left was taken December 18-19, 1947 (exposure 144 minutes), during Zeta Aurigae's recent eclipse; that at the right on February 5-6, 1948 (121 minutes). Enlargement is from Cramer Hi-speed plates used in a Ross-Fecker 3-inch camera. The three Kids of Auriga are conspicuous: Epsilon, an F-type star, at the top; Eta, a blue star, appearing very bright; and Zeta, marked by the arrow. Compare its brightness with that of the star above it; their magnitudes are nearly the same during eclipse. Harvard Observatory photographs.

typical of yellow stars, in the visible part of the spectrum, and wide, hazy lines of hydrogen (due to the blue star) in the ultraviolet. As shown in the first (November 11th) of our series of spectra on the front cover, in the violet region most of the lines we see are still those of the metals, and they belong to the yellow star, but the spectrum looks as though it had been light-struck. In fact that is just what happened; it is light-struck by the strong continuous spectrum of the blue star which partly drowns out the light of the yellow star.



This diagram shows the orbits of the components of Zeta Aurigae in a plane containing the line of sight to the earth. The orbit of each star is around the center of gravity of the system, and the stars are in the positions corresponding to mid-totality of the eclipse of the B star.

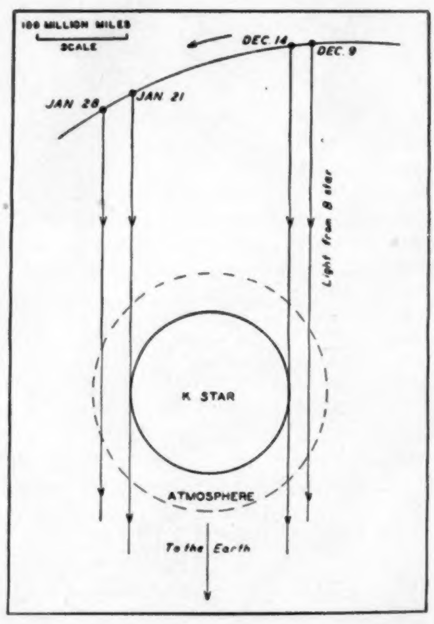
Although both stars give about equal amounts of light in the blue-violet spectrum, this does not mean they are anywhere near equal in size. The *B* star has a temperature of about 20,000 degrees absolute, against the *K* star's 4,000 degrees or so. According to radiation theory, every square mile of the *B* star's surface must give several hundred times as much light as each square mile of its cool companion. The only way their light could be equal, then, would be for the cool star to be many times larger than the hot one. Lacking exact temperatures, we can only assign limits, but it is calculated that the *K* star must be between 25 and 30 times greater in diameter than the *B* star. No wonder it produces a total eclipse that lasts five weeks!

When the light curve was determined, it was found that the dimming of the light, as the *B* star passed behind the edge of the giant, took about 32 hours, and the duration of totality, while the *B* star was traversing the diameter of its giant companion at practically uniform speed, was 37 days. It is then just a simple calculation to determine that the *K* star must be at least 28 times as large as the *B* star. This value fits in with the limits, 25 to 30, given by radiation theory. It is this sort of agreement that encourages the astronomer in the conviction that he is on firm ground when he applies the physical laws of radiation, as discovered for earthly material, to interpret his observations of the unattainable stars. The true dimensions of the components of Zeta Aurigae are about 200 times the sun's diameter for the *K* star and seven times for the *B* star. The huge cool globe would just fit loosely inside the earth's orbit.

The eclipsing character of Zeta Aurigae and the interesting things it can tell us were not all realized at a single stroke. The story of this star system is a good example of how scientific knowledge grows, and of how its growth is sometimes not as rapid as we believe, in retrospect, it should have been. Although this composite spectrum was known from the 1890's on, it was not until 1908 that the variation of its radial velocity was announced by W. H. Wright, of Lick Observatory. This established the system's binary character, but the elements of its orbit were not determined until 1924, when W. E. Harper published his results from the Dominion Astrophysical Observatory at Victoria. Harper showed that the period of revolution was two and two-thirds years, and that the orbit of the *K* star was somewhat elliptical, with an average radius of 184 million miles.

One of Harper's spectrograms appeared different from the others. The usual light-struck appearance, due to the spectrum of the *B* star, was missing. This particular observation was made when the *K* star was nearest the earth, and Harper suggested that an eclipse might be the explanation. Acting on this suggestion, observers in Germany confirmed the occurrence of an eclipse by photometric observations in the winter of 1931 to 1932, and also found the temporary presence of absorption lines due to the atmosphere of the *K*-type giant coming in front of the *B*-type star just before and just after the eclipse. The nature of the problem and the possibilities for extension of our knowledge of stellar atmospheres were now outlined, and the course of action to be followed by observers at the time of the next eclipse was clear.

In August, 1934, true to schedule, Zeta Aurigae showed the atmospheric eclipse lines for several days, then the *B*-type spectrum disappeared for 37 days, and after that again for several days the absorption lines due to the eclipse were observed. W. H. Christie and O. C. Wilson, at Mount Wilson Observatory, made extensive measures of the strength of these lines and analyzed in a preliminary way the stratification of different atoms in various states of excitation in the *K* star's atmosphere. Since then several more eclipses have been observed, and although they are alike in a general way, there is pretty clear evidence that at the time of the eclipse observed in 1937 there was an abnormally great amount of ionized calcium, ionized titanium, and hydrogen in the upper atmospheric layers. One is tempted to suggest that the *B* star passed behind a gigantic prominence! There also appears to be a lack of perfect symmetry of the atmosphere. During the approach to eclipse the *B* star passes behind denser layers of gas than it does after it leaves eclipse. It is as if the atmosphere were denser or more extensive on the forward-moving side of the giant *K* star than in its wake. In view of these variations, the eclipses of Zeta Aurigae will be important astronomical events for some time to come. As I write, the

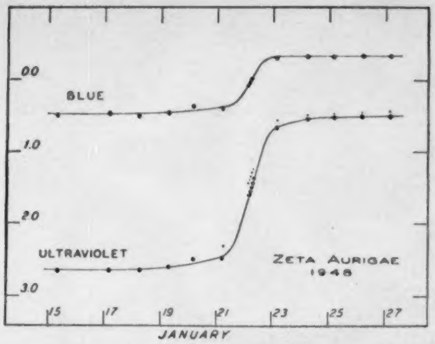


The motion of the B star relative to the K star during the eclipse. Totality began December 14th and ended January 21st. Compare the positions of the B star to the spectra on the front cover.

light signals of about 450 eclipses are on their way to the earth, stretched out over the 1,200 light-years of distance between Zeta Aurigae and us.

The recent eclipse was fairly typical of a normal one, with no prominence-like effects or other conspicuous irregularities. The record of the changes of the spectrum is outlined by the reproductions of Ann Arbor spectrograms on the front cover. Bad weather prevented observation of the first faint atmospheric eclipse lines. When the first spectrogram was taken December 9th, the *B* star was already shining through an extensive layer of hydrogen and ionized calcium. Two days later the path of the light was deeper in the atmosphere and lines of ionized titanium had become stronger. In two days more a great number of additional lines showed up, especially those of iron in the deeper strata of the atmosphere. Finally, December 14th, when less than half the disk of the *B* star projected beyond the edge of the giant, its rays had to pass entirely through the lowest layers, and a complete *K*-type spectrum was seen.

The five-week period of totality followed, and for purposes of comparison several spectrograms were taken of this stage. Then, on the night of January 21st, the *B* star halfway out of eclipse was again shining through the deeper layers of gas. The changes that followed were simply a repetition, in reverse, of those that had occurred during the approach to eclipse. Line after line faded away as the *B* star emerged from behind layer after layer of gas. The last lines to disappear were those of hydrogen and ionized calcium. Hydrogen was last recorded January 30th; ionized calcium was still seen the next night.



A preliminary plot of unpublished data furnished by Dr. Gerald E. Kron, Lick Observatory, from observations with a 1P28 photocell attached to the 36-inch Crossley reflector. The comparison star was Eta Aurigae; effective wave lengths are 3760 angstroms for the ultraviolet; 4250 for the blue; 3900 for the violet (marked by small dots). Many points represent several observations near each other in time, and the freehand curves merely approximate the light variation.

The steep part of each curve shows the rise in light during the 1¼ days as the B star emerged from total eclipse. Note that as compared with the blue, the ultraviolet light continued to increase while the B star still shone through the K star's atmosphere. A similar effect has been reported by Dr. Edison Pettit, of Mount Wilson Observatory, amounting to 0.07 magnitude in the blue and 0.12 in the ultraviolet. Data courtesy of Lick Observatory.

Then cloudy weather intervened for a few days, and by February 4th no trace of the fine, narrow eclipse lines remained.

In a general way, the arrangement of the atmospheric strata in Zeta Aurigae is similar to that of the sun's atmosphere, but on a vastly expanded scale. Metals in the neutral state, such as iron, manganese, and titanium, occupy the lowest layers. Higher up we find no neutral metals except magnesium; instead there are many ionized atoms of metals, especially titanium, with much hydrogen and ionized calcium. The highest layers show only hydrogen and ionized calcium, which extend above the giant star's surface to a distance equal to about half its radius.

Zeta Aurigae is not quite unique in its display of atmospheric structure. Close to it in the sky is Epsilon Aurigae, with a period of 27 years between eclipses and a duration of two years from beginning to end of eclipse. In this case, the eclipse is believed to be due wholly to the atmosphere of a giant star so cool that its spectrum contains no measurable visible light. We can hope to learn more about it when the next eclipse occurs in 1955 to 1957. Another giant system is VV Cephei (see "The Story of VV Cephei," by Victor Goedicke, *Sky and Telescope*, October, 1943), a huge *M*-type star and a *B*-type star, with a period of 20 years, whose eclipse phenomena are very similar to those of Zeta Aurigae but last more than a year. Its next performance is due in 1956 to 1957. Zeta Aurigae, because of its shorter period of less than three years, is to be ranked as the most important of this triumvirate, from which astronomers can get the answers to questions formerly believed to be unanswerable. And about 1956 all three of these stars will be eclipsing, furnishing a celestial three-ring circus that will not be duplicated until some 80 years later.

NEW BRIGHT COMET

AS WE GO TO PRESS a new naked eye comet appears in the morning skies. It was found just slightly north of the loose cluster M34 in Perseus by the Japanese astronomer Minoru Honda, on June 2nd, at 2^h 40^m, $+43°$. Nothing was first reported about its appearance except it was of the 4th magnitude with a tail greater than 1°. It was independently discovered on June 4th by the Italian astronomer Giovanni Bernasconi. He reported an estimated daily motion of 10^m west and 2° 30′ north.

Hopes were immediately aroused that here might be a comet for observers in the northern hemisphere which would equal the spectacular southern Great Comet of 1947 (See **Sky and Telescope**, February, 1948). However, the greatest magnitude reported was 3rd from Copenhagen; later reports having indicated its magnitude to be between 5th and 6th, with no notable increase expected.

Professor G. Van Beisbroeck, observing with the 24-inch Yerkes reflector, reported on June 10th that the comet was of magnitude 5.2, with a sharp nucleus, a coma of 5′ and a tail over 2°. His position placed it close to the gaseous nebula M76 in Perseus.

Dr. L. E. Cunningham, Student's Observatory, University of California, sent the following ephemeris based on early observations:

1948	U.T.	R.A.		Dec.		Mag.	
		h	m	°	′	"4"	"6"
June	14.0	0	47.1	+53	52	5.3	5.8
	18.0	23	49.7	+55	22	5.7	6.4
	22.0	22	52.8	+55	10	6.1	7.0
	26.0	22	01.3	+53	28	6.5	7.6
	30.0	21	18.1	+50	43	6.9	8.1
July	4.0	20	43.5	+47	19	7.3	8.7
	8.0	20	16.1	+43	38	7.7	9.2
	12.0	19	54.8	+39	55	8.1	9.7
	16.0	19	38.0	+36	19	8.5	10.2
	20.0	19	24.9	+32	54	8.8	10.6
	24.0	19	14.5	+29	43	9.2	11.1
	28.0	19	06.4	+26	47	9.6	11.5
Aug.	1.0	19	00.1	+24	06	9.9	11.9
	5.0	18	55.3	+21	38	10.2	12.3
	9.0	18	51.6	+19	23	10.5	12.7
	13.0	18	49.0	+17	21	10.8	13.1

Magnitudes "4" in the table above are estimated on the fourth power of the distance law; magnitudes "6" are based on a sixth power law.

Paul Stevens, of Rochester, New York, on June 6th, observed the new comet. In his letter to the editor, he described the object as having a nucleus visible to the naked eye, while with a pair of six power binoculars, the head and tail provided the finest view of any comet he had ever seen.

Amateurs with moderate size telescopes should be able to follow Comet Honda-Bernasconi during most of July without too much difficulty.

R.E.C.

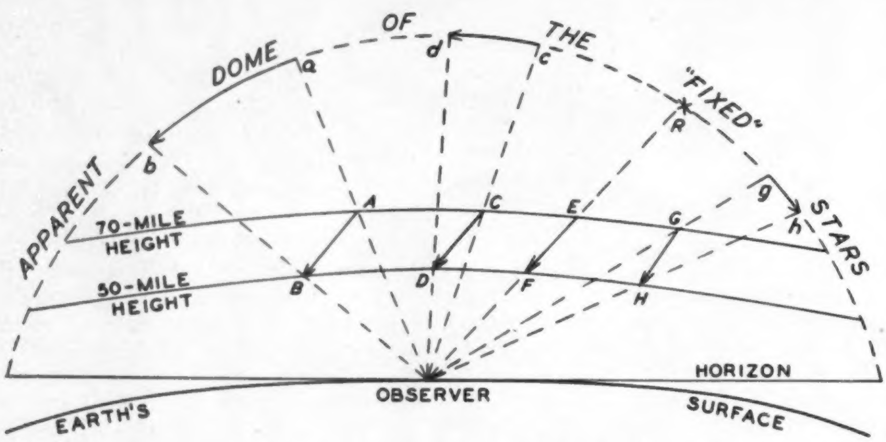
TERMINOLOGY TALKS -- J. Hugh Pruett

An effect of perspective — meteors of a shower radiate from a single small area.

Explanation of radiant

Some may wonder why the meteoric bits traveling around the sun in parallel paths should, when they strike the earth's airy covering, spread out in all directions from the radiant. They really do not do this, but merely seem to do so. It is a case of perspective. We sense all luminous phenomena on the sky to be at about the same distance from us. No matter where a meteor is, it seems to be moving along the celestial sphere at about right angles to our line of sight. In the accompanying diagram, in which many things are not in proportion, we show why we get this effect.

Shower meteors begin to glow when somewhere around 70 miles above the earth's surface and are completely burned to vapor and ash at about the 50-mile height; only in this region of the air are they visible. Their luminous paths in the atmosphere are therefore approximately *AB, CD, EF,* and *GH.* Now the particle traveling through *EF* is coming directly toward the observer, so will seem to be a stationary spot of light for an instant at *R,* the radiant of the shower. The path *CD* is seen by us as moving from *c* to *d* in a short path on the celestial sphere to the left of the radiant. In the same way, *GH* is seen as *gh* to the right of *R.* The farther each little glider appears from *R,* the longer is its apparent luminous flight. This is shown nicely by *AB* and *ab.* Veteran Perseid observers know that by facing well away from the radiant the longest flights are seen.



How perspective produces the effect of a radiant for nearly parallel meteors of a shower entering the atmosphere. In actuality, of course, not all the meteor trails have the same heights and lengths.

Geocentric and Heliocentric Velocities

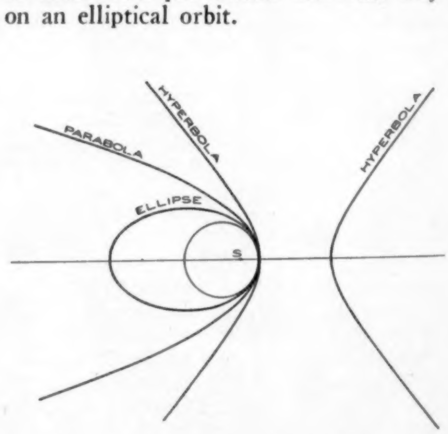
The speed of a railroad train is usually expressed relative to the surface of the earth over which the train travels. For a train moving eastward at the equator we must add about 1,040 miles an hour if we are to use the earth's center as a reference point, for the railroad track itself is hurrying along at that rate due to the earth's rotation. If we further refer the motion to the sun's center, the train and all objects on the earth become very speedy travelers, for the orbital velocity of the earth around the sun adds another 66,600 miles per hour.

Meteor velocities stated in respect to the earth's center are known as *geocentric;* to the sun's center, *heliocentric.* Since the rotational velocity of any part of the earth's surface and atmosphere is only a fraction of a mile per second, it generally makes little difference whether reference is made to the earth's center or to its airy covering.

Were the earth stationary with reference to the sun and the solar system, meteors would all enter its atmosphere at the same velocity. A typical velocity might be about 25 miles per second, sufficient to make a meteor glow quite brightly as a result of friction with the air. But the earth moves eastward around the sun at 18.5 miles per second, so a meteor meeting our planet head on at 25 miles per second dashes into the upper air at a geocentric velocity of 43.5 miles per second. On the other hand, a meteor which overtakes us at 25 miles per second may have a net speed downward of only 6½ miles per second.

Encounters exactly like these idealized examples are comparatively uncommon, for most meteors approach from the side, more or less at an angle to the line of the earth's travel, but it is always possible to compute the resultant geocentric velocity if the meteor's speed and line of travel are known. The Leonid meteors in November meet the earth nearly head on, so they have a higher geocentric velocity (nearly 45 miles per second) than do those of other well-known showers. For the August Perseids, the geocentric velocity is 38 miles per second, while for the Draconids, seen in such numbers on October 9, 1946, it is only 14. The latter were decidedly slow-moving objects.

There are three types of orbits in which meteoric particles might conceivably be traveling through the solar system. One is that of an ellipse, a closed curve which can most simply be described as an oval (almost any text on geometry carries a full explanation). Any planet or bit of material moving around the sun in an ellipse is a relatively permanent member of the solar system. At any place on such an elliptical orbit, the velocity of the body depends upon its distance from the sun and the size of the ellipse. For the earth at its mean distance from the sun (93 million miles) this velocity turns out to be 18.5 miles per second, but it varies from 18.2 to 18.8 as the distance to the sun changes slightly through the year. But most important for our present discussion is the fact that any object at a distance of 93 million miles from the sun could have a heliocentric velocity up to 26.2 miles per second and still stay on an elliptical orbit.



Possible paths of celestial bodies around the sun. If an orbit is a circle, the attracting body is at its center. The hyperbola has a second branch, around an empty focus.

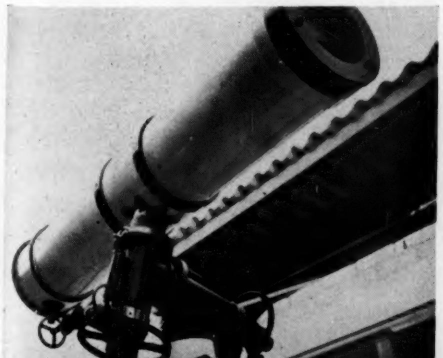
Astronomical Society of Mexico

By Domingo Taboada

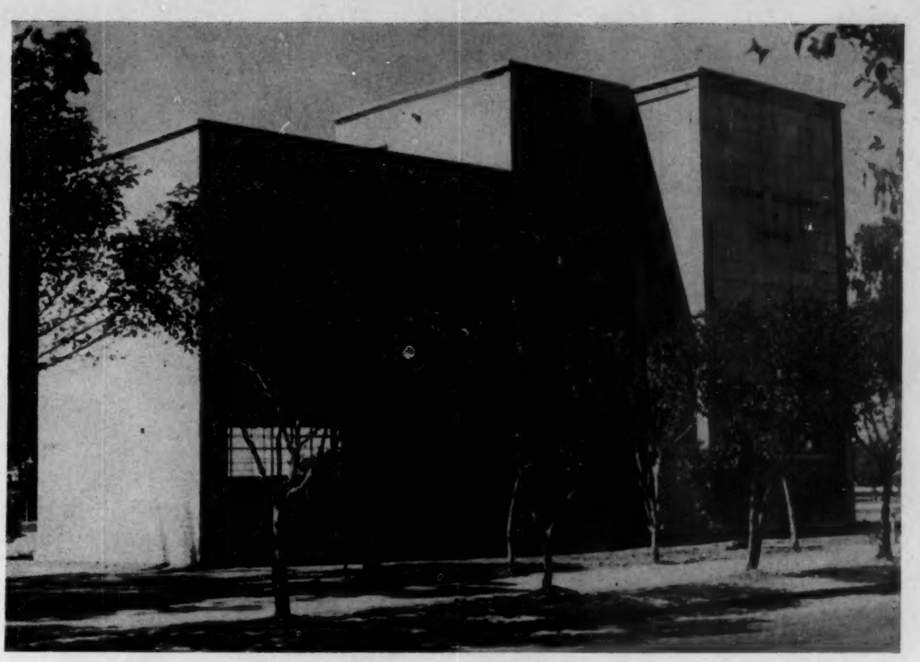
THE EXISTENCE of the Sociedad Astronomica de Mexico is related to a very interesting man and to an unusual astronomical event. The man was Professor Luis G. Leon; the event was Nova Persei 1901.

Professor Leon started his career as a student of military sciences and crafts in the Colegio Militar de Chapultepec (our West Point of legendary history). In the course of time he became an ardent pacifist and a militant antimilitarist, probably because of his self-taught knowledge of astronomy. In one of the turrets of Chapultepec Castle (where the Colegio Militar was located), there was a 4-inch French refractor equatorially mounted with a rather good clock drive, a set of oculars, a micrometer, some charts of the sky, and a few other gadgets. Also there were numerous books on astronomy popular at that time. Cadet Leon found the instrument in a lamentable state of preservation, and obtained the necessary authorization to spend a few night hours in the "observatory" each week — time which had to come out of his sleep.

Very soon he began to talk to his fellow cadets about his marvelous experiences with the telescope: Saturn really had rings that could be seen; markings on Mars were discernible. The interest in astronomy was quickly aroused, and in a few weeks a group of about 25 would-be warriors had organized a course under Leon as teacher, for which he received a fee of 25 cents per week per student. This was exactly the Spartan weekly allowance for extracurricular expenses received by each student, amounting to about one nickel in American money, and indicates the incredible capacity Leon had for interesting people in astronomy. In his hands, the teaching fees were used for maintenance and repairs in the observatory and for printing astronomical tables and other items for the class. In this monastic poverty, Leon started his life work of teaching and popularizing astronomical knowledge, a career in which he was successful.



The 12-inch Fecker reflector, positioned for closing the slide-off roof.



Front view of the new building of the Astronomical Society of Mexico. The 12-inch reflector is housed on the top floor. Photo by G. F. Herrera.

In February of 1901 the outburst of Nova Persei was observed by Judge Felipe Rivera in the small town of Zinapecuaro in Michoacan. Judge Rivera wired the news to Professor Leon, who realized immediately the importance of organizing all amateur astronomers.

He then proceeded to form the Sociedad Astronomica de Mexico. The average monthly number of new members of the society for the year 1911 was over 60, with an obviously increasing trend.

The society published a monthly bulletin, and operated a popular observatory, with a 5-inch refractor by Mailhat, located in a public park in Mexico City. For 12 months beginning in December, 1908, the number of people who visited the observatory to observe either the sun or the stars totaled 12,455, or an average of well over 1,000 per month.

The society's founder was re-elected year after year to the all-important post of general secretary. The society had many by-products. About 12 or 15 private observatories were established in many different cities by enthusiastic amateurs. Practically every college was provided with an observatory, and cosmography and elementary astronomy were introduced into the regular college curriculum. And last, but not least, the Tonanzintla Observatory was founded by men that were initiated into astronomy by Professor Leon. (See *Sky and Telescope,* December, 1941, and April, 1942.)

Whatever the importance of the Mexican social revolution of 1913 to 1929 on other fields, its impact on the astronomical society was deadly. There was also the sudden and untimely death of Professor Leon. His passing was so rapidly followed by the decadence of the society that one is tempted to link both facts into cause and effect. It is not so. He was an exceptional man, but Professor Leon was not indispensable after the first few years of the society's existence, and his high sense of public service led him to provide for leadership by others. The total eclipse of the society from 1913 to 1938 was due essentially to the separation of the Mexican community into many incompatible branches. The reorganization in 1938 was carried on, however, entirely by men who had been active with Professor Leon, all of them members of the original organization.

Progress has been swift in the past 10 years, and on November 18, 1946, the new building of the Sociedad Astronomica de Mexico was dedicated by the mayor of Mexico City, Dr. Javier Rojo Gomez. This building, planned on the principles of functional architecture, is located in a public park in a populous district of the city, in accordance with our old tradition. The main floor contains a classroom for about 100 persons, two ample rooms destined to be used as shops for amateur telescope making, and janitor's lodgings. The second

floor has a lecture room for about 150 people, offices for the society leaders, a library, a photographic laboratory, and a meeting room for the trustees and technical advisers.

The observatory itself is on the third floor, with a 12-inch reflector with equatorial mounting and electric clock drive by Fecker. There is a darkroom, and two ample terraces where two portable refractors can be put to service for interested visitors and where naked-eye astronomy can be explained.

The main activities of the society include periodic short courses in elementary astronomy conducted by Professor Elpidio Lopez and Professor Francisco Escalante. The latter also is in charge of variable star work by members in collaboration with the AAVSO. There are bi-weekly lectures on astronomy and related sciences, the 1947 talks covering such widely diversified subjects as astronomical history, the Schmidt camera of Tonanzintla, variable stars, amateur telescope making, invisible stars (*las estrellas que no se ven*), and the determination of the mass of the earth.

Invitations to visit the observatory are issued under a prearranged calendar to educational centers and schools. The students come mornings, afternoons, and evenings with their own teachers and the society provides the lecturer or the observing director according to the occasion. We issue a tri-monthly publication named *El Universo,* which it is hoped will become the most important periodical for the popularization of astronomy in Mexico.

The chairman of our board of directors for 1947-48 is Civil Engineer Francisco Bravo, and the writer is assistant chairman. Our general secretary is Professor Elpidio Lopez; recorder, E. Vivanco; assistant secretary, Mrs. R. G. Le Royal; treasurer, E. C. Blasco. The voting members of the board are Dr. G. Montiel, J. Presno, and G. F. Herrera.

The names of our board of technical advisers are A. B. Celis, Dr. P. C. Garrorena, Professor L. E. Erro, Dr. J. Gallo, Dr. C. Graef Fernandez, Dr. G. Munch, Dr. A. N. Gandara, G. H. Rodriguez, Dr. M. S. Vallarta, and N. Vazquez.

For those of us who can remember what the society was in the first decade of this century and can compare it with today's activities, it is noticeable that the interest in astronomy is as great today as it was 30 years ago, but with the emphasis on a very different set of topics. A perusal of the old bulletin of the society shows the most effective tools of the writer or lecturer on elementary astronomy in those days to have included Bode's law, Kepler's laws, Newtonian gravitation, asteroids, the surface markings of Jupiter and Mars, and the discovery of Neptune. On the observa-

(Continued on page 229)

NEWS NOTES

BY DORRIT HOFFLEIT

METHANE IN THE EARTH'S ATMOSPHERE

The presence of methane, the "marsh gas" that forms a conspicuous constituent of Jupiter's atmosphere, has now been detected in the earth's atmosphere through analysis of the sun's infrared spectrum by astronomers Robert R. McMath, Orren C. Mohler, and Leo Goldberg, of the McMath-Hulbert Observatory, University of Michigan. Previously, chemical analyses had revealed small quantities of atmospheric methane, but the new studies should make possible a more accurate study of the structure of the methane molecule than has been possible heretofore.

EARTH'S MAGNETISM 100,000,000 YEARS AGO

While Arctic explorers are busy trying to pin down the present exact location of the earth's magnetic pole, which seems to migrate (see *Arctic,* I, 1, Spring, 1948, for the present status of this work), the Carnegie Institution of Washington is busy in the western United States collecting data for finding out where the compass would have been pointing a hundred million years ago. Within the clay particles deposited at the bottoms of glacial lakes and oceans are tiny magnetic particles, which can be used to find the strength and direction of the magnetic field at the times when the clays were deposited. Pieces of the material are spun near a coil of wire and extremely sensitive amplifiers pick up the very small voltages generated.

Glacial deposits from New England and the Pacific have already shown that the earth's magnetic field a million years ago was just about what it is now. The clays now being sought should extend the study back 100 times as far. Science Service comments that Dr. E. A. Johnson, of the Carnegie Institution, hopes the new data will help answer the fundamental question: Why is the earth a giant magnet?

ECLIPSES FOR 150 YEARS IN THE UNITED STATES

Dr. C. H. Cleminshaw, of the Griffith Observatory, Los Angeles, announces that his institution will be open for observations of the total eclipse of the sun on Saturday, August 12, 2045, although it is not now certain just how close to that area of California the moon's umbra will fall. This will be the 15th total solar eclipse visible from somewhere in the United States since the dawn of the 20th century (an average of one eclipse a decade). Six of these have already occurred, in 1900, 1918, 1923, 1925, 1932, and 1945.

The seventh eclipse will occur on June 30, 1954, visible from northeastern Nebraska through the northernmost tip of Michigan and across Lake Superior into Canada. On October 2, 1959, the moon's shadow strikes southern New England before crossing the Atlantic Ocean. The next eclipse, in 1963, cuts across Maine; the one in 1970 is visible in Florida; while that in 1979 cuts into Washington, Idaho, and Montana. These five most of us hope to observe (for paths see *Sky and Telescope,* April, 1945, page 13), but few of us now expect to see the remaining four, 2017, 2024, 2044, and 2045, for which Dr. Cleminshaw charts approximate paths in the *Griffith Observer* for May, 1948. Those on August 21, 2017, and August 12, 2045, will surely be successfully observed as they will cross the entire continent.

METEOR VELOCITIES FROM RADIO WAVES

In the British journal *Nature,* C. D. Elyett and J. D. Davies, of the University of Manchester, report on a promising new method for the determination of meteor velocities from "the diffraction pattern of radio waves scattered from the electron trail as a meteor passes at right angles through the aerial beam." This method was applied to the 1947 Geminids and the 1948 Quadrantids. The radio unit operated on a wave length of 4.2 meters.

The mean geocentric velocity found for the Geminids was 34.4 kilometers per second, agreeing excellently with Whipple's value of 34.7 obtained from rotating-shutter cameras. For the Quadrantids (30 meteors), the radio data indicated three velocity groups: a low velocity group had a mean velocity of 22.4 kilometers per second; the others had maximum frequencies at 34 and 41 kilometers per second. Early analyses by W. J. Fisher of visual estimates for the Quadrantids indicated velocities between 32 and 41 kilometers per second. The low-velocity radio meteors may not be Quadrantids.

HENRY DRAPER MEDAL

The Henry Draper medal of the National Academy of Sciences for 1947 was conferred upon Dr. Hans Bethe, professor of physics at Cornell University, in recognition of his contributions to astrophysics. The carbon-cycle theory for the generation of energy in the sun and stars was first proposed by Dr. Bethe in 1939.

Annular Eclipse Observations
Reported from the Pacific

WEATHER conditions along the path of the annular eclipse of May 8-9 turned out mostly unfavorable, but the earlier reports that only two of the seven National Geographic observing stations were successful are now supplemented with accounts which indicate a greater percentage of good fortune.

In late May, when the film records of the eclipse were already back in Washington, there was a delay of from two to three weeks in their processing in order to have the top photo expert with the expeditions supervise the work upon his return from the Orient.

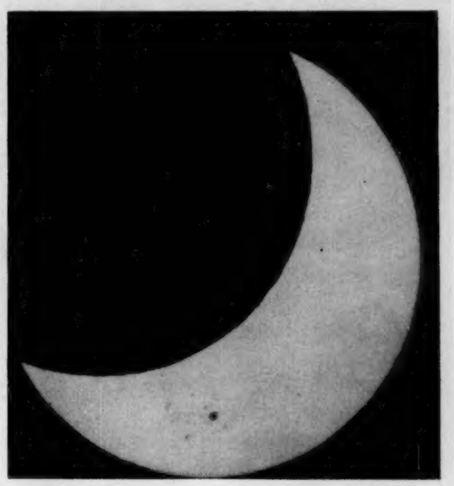
The observing parties at Bangkok, Siam, and Ruben Jima, Japan, were successful, while there is a good chance that the observers at Mergui, Burma, managed to catch the second and third contacts — beginning and ending of the annular phase. On Mt. Moffett, Adak, in the Aleutians, first contact was filmed satisfactorily, while second and third contacts were observed through a driving snowstorm. The revised estimates for Burma and Adak were subject to confirmation when the films were developed.

But what may turn out to be the best story of the eclipse is that of the reported success of the two B-29 airplanes from the Army Air Forces Control Group, MacDill Field, Tampa, Fla., which flew to the Aleutians for the eclipse, operating from the air base on Shemya Island. Both were equipped with special long-focus cameras and had photographic crews from Wright Field, Ohio. These Superforts flew above the snowstorm to obtain excellent pictures.

If analysis of these photographs shows them useful for geodetic purposes, the primary aim of the entire National Geographic eclipse program may yet have been achieved: to tie together the North American and the various Asiatic geodetic triangulation systems. This possibility depends upon how accurately the position of each B-29 can be determined for the time of exposure of each frame of the motion pictures which were taken at the four contacts of the eclipse.

Each plane was equipped with shoran (short range navigation) equipment, by means of which it broadcast radar signals to ground stations on Amchitka and Tanaga islands. From these stations the signals were sent back to the planes. The interval between the departure of a signal and its return from the shoran ground station should provide data for a precise plotting of the plane's position at that instant, as the exact locations of the ground stations are known. Major George H. Wyman, of Andrews Field, Md., was the project commander for the B-29 observation program.

Dr. Lyman J. Briggs, chairman of the National Geographic Society's committee on research, pointed out that until the B-29's reported, the eclipse program had produced definite data only for a single geodetic tie-in: Siam-Japan. The Superforts can add to this Siam-Aleutians and Japan-Aleutians. The partial success at Mergui may further improve the very important tie-in with the British Indian system in eastern Burma.



The partial eclipse as photographed by Ricardo C. Cruz at Manila.

Standard equipment at the seven ground observing stations was a coelostat feeding sunlight into a long-focus lens. The resultant 11-millimeter image was photographed by a 35-millimeter motion picture camera, 24 times a second during the four eclipse contacts. The short time between second and third contacts for this annular eclipse made possible continuous operation of each camera during the annular phase. The film's sound track was used to record the one-per-second ticks of a chronometer, exact time being furnished by rebroadcast of National Bureau of Standards time signals by State Department facilities in California and Hawaii. About a day before the eclipse, severe ionospheric storms seemed to be developing, but the Hawaiian rebroadcast station had its choice of the best of six different frequency channels.

The best observations reported were from Ruben Jima, where the expedition was headed by Dr. John A. O'Keefe, on a fishermen's island off the northwestern tip of Japan. Heavy clouds and a cold drizzle preceded eclipse time, but ideally clear conditions set in at the crucial moment. At Bangkok, Dr. Charles H. Smiley's expedition also was lucky, for heavy monsoon rains ceased just before the zero hour, and the party observed successfully through thin cirrus clouds.

Completely negative results were reported by Dr. F. J. Heyden, S.J., at Wukang, China; from Dr. George Van Biesbroeck, at Tenan, Korea, and for Mt. Adagdak, Adak Island, but there Lt. Comdr. George Shelton had somewhat better success with his second party on Mt. Moffett, as already noted. At the beginning of the eclipse path, Edward A. Halbach's Burma party was possibly also partially successful.

A partial eclipse of maximum magnitude 66 per cent was observed in the Philippines by Ricardo C. Cruz, who established his equipment at the Weather Bureau station on the Marsman building, Port Area, Manila. He used a standard Graflex camera with the lens removed, attached to the 3-inch refractor pictured here. A 16-power eyepiece was employed and the objective stopped to 1 1/8 inches, with a green Omag filter in the eyepiece. Focal-plane shutter speed was 1/1,000 second. Mr. Cruz writes:

"The materials for the equipment, including the camera, were bought locally with funds made available by the U. S. Weather Bureau mission under Foster V. Jones presently undertaking rehabilitation of the Philippine Weather Bureau, which completely lost its plant and equipment in the last war. The equatorial mounting of one-inch pipes on a wooden base was hurriedly made in our shops especially for the observations. The objective lens and eyepiece, however, were salvaged from war materials found in the ruins of South Manila after liberation in 1945 — they may be parts of a range finder."

The equipment used by Ricardo C. Cruz to photograph the partial eclipse.

Amateur Astronomers

Middle East Region of League Organized

ALTHOUGH the convention for the purpose of organizing a proposed region of the Astronomical League, at which the Amateur Astronomers Association of Pittsburgh was host society, was scheduled for May 14th to 16th, residents of that city had a preview of things to come when the Stargazers Fair opened at the Buhl Planetarium on Sunday, May 9th. On exhibit were 28 telescopes, indicating a wide variety of finishing touches put on their instruments by members of the Pittsburgh group. In addition, exhibits included a disassembled 6-inch Newtonian reflector, numerous photographs of astronomical subjects, charts, drawings, and two amateur-made telescopes almost 70 years old.

Many delegates to the convention had arrived by Friday evening to attend the regular monthly meeting of the Pittsburgh AAA, at which D. W. Rial, of the Carnegie Museum, spoke on "Sundials."

The opening session of the convention Saturday morning was called to order by the writer, general chairman of the convention committee, who first read those portions of the league by-laws which govern regions and regional activities. He then introduced James B. Rothschild, executive secretary of the league, who outlined the business at hand, including the boundaries and a name for the region. Following this discussion a five-minute recess was taken so that each member organization present could appoint a member to the temporary regional council. This council met during lunch.

At the second session, under the chairmanship of H. Malcolm Priest, of Pittsburgh, it was voted that the regional name be Middle East, that the fiscal year run from May 1st to April 30th, and that the terms of regional officers begin on September 1st, ending August 31st.

The following regional officers were elected: chairman, C. H. LeRoy, Pittsburgh; vice-chairman, Mabel Sterns, Washington, D. C.; secretary, Elizabeth Fazekas, Norfolk, Va.; treasurer, Edwin F. Bailey, Philadelphia. During the counting of the ballots for each office, representatives present gave a brief outline of the activities in their respective organizations. After adjournment of the second session at 3:00 p.m., delegates and visitors were entertained with a sky show, "Weather Forecasting," as guests of the Buhl Planetarium.

At the closing gathering that evening, the speaker was Dr. Nicholas E. Wagman, director of Allegheny Observatory, who chose as his topic, "Life in the Universe." Following this the newly elected regional chairman offered a three-fold program for the region: That amateurs make their instruments available to the general public as much as possible; that a definite program for junior groups be fostered; that a detailed report of this convention be promptly placed at the disposal of every member organization.

After this final session came to an end, we all went to Allegheny Observatory to spend several hours in observing with the 30-inch Thaw refractor and other telescopes, visiting the Brashear crypt, and examining the spectroscope.

Most delegates remained to make an inspection trip to the Unertl Optical Company on Sunday morning, under the personal guidance of John Unertl, who presented each visitor with a neat little package containing the objective and eyepiece lenses for a 2¼-inch refracting telescope. Sunday afternoon many guests were taken on a motor caravan trip to points of interest in the Pittsburgh area.

CHARLES H. LEROY
AAA of Pittsburgh

Delegates and guests at the first convention of the Middle East region of the Astronomical League, taken in front of the Buhl Planetarium and Institute of Popular Science, Pittsburgh. Photo by Willard A. MacCalla.

TELESCOPE MAKERS TO CONVENE AT STELLAFANE

THE SPRINGFIELD Telescope Makers cordially invite you and all your telescope making friends to another convention at Stellafane this year. The date is Saturday, August 7th, during the first quarter of the moon. In order to stimulate the exhibit of telescopes, we are offering a reduced rate for every personally constructed instrument that is displayed on Breezy Hill in working order. A prize will be awarded to the club bringing the greatest number of 'scopes and to the individual with the most ingenious, original design. Judging will start at 3 p.m. and all entries must be set up by 4 p.m.

The banquet will be served at 5 o'clock in the afternoon. The fee this year will be $4.00, but $3.00 for those with their own instruments, covering registration, parking, the banquet, and expenses of the program. We must have your registration fee no later than July 1st if you are to be guaranteed a seat at the festive board. The banquet is going to be something out of this world. We have been fortunate enough to obtain the services of Ross McKinney, a famous Maine guide, who will prepare an outdoor feast over a mile-long pit of fiery coals and serve it up in Waldorf style.

A stellar program is being arranged for the evening. Russell W. Porter plans to be East on business this summer and is trying to arrange his time to meet our convention date.

Hotel reservations should be made directly. We recommend the Adnabrown Hotel, Springfield, Vt.; Fullerton Inn, Chester; Hartness House (a Treadway Inn), Springfield; Windham Hotel, Bellows Falls.

We are looking forward to making new acquaintances and renewing old ones.

JOHN W. LOVELY, secretary
26 Orchard St.
Springfield, Vt.

THIS MONTH'S MEETINGS

Indianapolis: Members of the Indiana Astronomical Society will hold a public meeting, with telescopes, on the evening of July 4th in Butler Bowl.

Kalamazoo: A potluck supper at Wolf Lake will be held on July 10th at 6:00 p.m. by members of the Kalamazoo Amateur Astronomical Association. Max Kester will speak on "A Primer of Astronomy."

Milwaukee: On July 3-5, the national convention of the Astronomical League will be held at Concordia College, with excursions to the Milwaukee Astronomical Society Observatory and to Yerkes Observatory at Williams Bay, Wis.

Los Angeles: Dr. Robert S. Richardson, of the Mount Wilson Observatory staff, will address the Los Angeles Astronomical Society on "Rockets Into Space," at the lecture meeting on July 13th at 8 p.m., in the Griffith Observatory.

AAVSO Convenes at Mount Holyoke College for Spring Meeting

JUST TWO NAMES appeared on the first published list of variable star observers and their observations, in the November, 1911, issue of *Popular Astronomy*. One was William Tyler Olcott, and the other Miss Anne S. Young. At the 37th spring meeting of the American Association of Variable Star Observers, held May 21-22 on the campus of Mount Holyoke College, South Hadley, Mass., there was a ceremony in recognition of her lifelong devotion to astronomy, initiated by the "astronomy alumnae" of the college. A portrait photograph of Miss Young was unveiled, and announcement was made by Dr. Helen Sawyer Hogg, former Mount Holyoke student now on the staff of David Dunlap Observatory, of the presentation to the John Payson Williston Observatory of a piece of astronomical equipment. At the time of the meeting, a corsage of orchids was delivered to Miss Young, who since her retirement as director of the observatory for the years 1899 to 1936 has been living in Claremont, Calif.

The present director, Dr. Alice H. Farnsworth, spoke earlier in the day of the long interest in astronomy manifest at the college. In the early prospectuses of the Mount Holyoke Female Seminary, which opened in 1837, it was suggested that students bring to college with them a Bible, an English dictionary, hymn book, volumes of poetry, and, if possible, a copy of Burritt's *Geography of the Heavens*.

Open house was held at the observatory on Friday evening, May 21st, following a buffet supper served for AAVSO'ers, and there was opportunity to inspect the equipment, although observing was not possible. Now the oldest building on the campus, the observatory houses an 8-inch Alvan Clark refractor, remounted by Fecker in 1929 with a Ross camera on the same mounting.

Early risers Saturday morning took a bird walk around the lakes through the bird sanctuaries, and the business meeting convened at 10 o'clock, with President Marjorie Williams in the chair. Two new activities of the solar division were reported by Neal J. Heines. In addition to the regular programs of observing sunspots, granular surface variations, and migratory birds, the solar division is now co-operating with Dr. Walter O. Roberts, of the High Altitude Observatory, in reporting rapid changes in sunspot patterns and other unusual details, such as color in spots, bridges, rapid or unusual spot disintegrations. In addition, 25 observers are participating in a program on foreshortening in sunspots initiated by Dr. W. Gleissberg, of the University Observatory at Istanbul, Turkey. In a paper forwarded by Dr. Gleissberg for the afternoon solar symposium, he predicts a slow decline of the present cycle, in that not before May, 1952, will the smoothed relative sunspot number fall below one quarter of the value of the May, 1947, maximum. Then, according to Dr. Gleissberg, the minimum, probably not deep, will follow within 20 months, succeeded by a very steep ascent in which the smoothed relative spot number will rise within 32 months from a quarter of maximum to maximum.

The names of 20 new AAVSO annual and four life members were read, and announcement was made of the appointment of Ralph N. Buckstaff, of Oshkosh, Wis., who was present at the meeting, as chairman of the AAVSO delegates at the Astronomical League convention in Milwaukee.

Among the papers presented at the morning session was one by Dr. Hogg, who spoke on "Variable Stars in Clusters." In her study of 62 globular clusters, she has discovered numbers of RR Lyrae-type (cluster-type) variables, with periods less than 24 hours. Some dozen or so W Virginis-type stars, having periods over two weeks, are known to exist in globular clusters. A working plate of M13, shown as a slide, of one- or two-minute exposure, provided interesting contrast to the familiar long-exposure plates of this great globular in Hercules.

The sun as a "microwave variable" was discussed by Dr. Martha Stahr, of Cornell University. A new microwave "telescope" is being built at Cornell University, in a project sponsored by the university and the Office of Naval Research, to carry on solar observations in this new field, in which the first published account appeared in 1944. Dr. Stahr outlined some of the problems under investigation. Radio energy propagated by the sun is many times stronger than would be expected from a body with a surface temperature of 6,000°. It has been proposed that this "noise" is from the high-temperature corona rather than from the solar surface. *Bursts* have been observed, which last a few seconds and occur without correlation on different wave lengths. Other outbreaks, classified as *outbursts*, last longer, are of greater intensity, and occur simultaneously on a number of wave lengths.

A paper on "Timing Algol" was presented by Roy A. Seely, past president of the association. He has worked out a graphical method for predicting the times of minima of Algol taking into account the effect of the light equation, which depends on the relative positions of the earth, the sun, and Algol.

After luncheon, at which Recorder Leon Campbell surveyed the growing work of the association, the afternoon solar symposium was held. The closing feature of this meeting was the presentation by James Stokley, General Electric Company, of a colored documentary film made by the National Geographic Society, "Eclipse Hunting in Brazil," which described the expedition to Bocayuva for the May 20, 1947, total solar eclipse.

H.S.F.

SACRAMENTO VALLEY'S THIRD ANNIVERSARY

At the meeting March 30th which celebrated the third anniversary of the Sacramento Valley Astronomical Society, the retiring president, Samuel J. Smyth, reported some of the accomplishments of the past year. Among these were the exhibit of a score of members' telescopes together with photographs of the heavens, many of them the product of local talent, at the California State Fair, which was attended by over a million persons; the introduction of a descriptive astronomy course at Sacramento State College; the publishing of a monthly news letter of local astronomical and society interest; the contributions of time, money, and effort of some of the members toward the rebuilding and reconditioning of the 12½-inch telescope at Sacramento State College (April **Sky and Telescope,** page 145).

On May 25th we were privileged to view the film, "Cinema et Astronomie," produced by the Astronomical Society of France and distributed by the French Embassy in New York City. The lapse-time photography of eclipses and eruptive prominences is especially spectacular and instructive. Amateur groups may secure this film, free of charge for educational purposes, by addressing the Office of Cultural Relation, French Embassy, 934 Fifth Ave., New York 21, N. Y.

One of the future activities of the society will be to broaden the use of the present telescope, and to explore the possibility of founding a more ambitious observatory, as Sacramento enjoys generally favorable observing conditions. Also, at this meeting, the constitution was amended to include a subscription to **Sky and Telescope** as a privilege of membership.

The following officers and directors were elected for the coming year: Harold Simmons, president; Mrs. Elizabeth Champ, vice-president; the undersigned, secretary-treasurer; Mr. Smyth, junior president.

MRS. HELEN SCHOPKE
3111—12th Ave.
Sacramento 17, Calif.

NEW OBSERVATORY

At Alderson-Broaddus College, Philippi, W. Va., a new observatory was opened late this spring, housing a 6½-inch Mogey refractor. The building, on the campus, is circular, constructed of cement blocks, and fitted with a revolving dome. The telescope, f/15, is of high-precision Jena glass, and the instrument is equipped with a 2-inch finder. An electric motor drives the telescope in right ascension, and there is a hand control for slow motion.

The "old moon in the new moon's arms." The bright crescent is illuminated by direct sunshine, the remaining features by light reflected from the daytime side of the earth. North is at the top. Yerkes Observatory photograph.

MOON TALES

By Robert R. Coles, *Hayden Planetarium*

WHILE FEW PEOPLE have probably considered the matter seriously, our world would seem very different without the moon. Aside from the physical effect that it has on the earth and its role in such phenomena as eclipses, there are a thousand and one other ways in which it has influenced man and his civilization.

The moon was probably the first celestial object to be seriously observed and studied and may therefore be credited with having inspired man's first interest in astronomy. Its apparent changes in phase, the daily retardation of its time of rising, the interesting appearance of its illuminated surface, the regularity of its behavior, all called for explanations. Later observers discovered also that lunar motions were correlated with the ocean tides, and it became obvious that this mysterious neighbor world was influencing the earth in strange and subtle ways. And at a very early time the changing moon suggested the basis of the calendar, thereby serving a very practical end.

Details of the above-mentioned facts are common knowledge available in almost every textbook on general astronomy. In addition, there is an almost inexhaustible source of interesting and curious material about the moon, or inspired by it. Like every other celestial object, the moon is the common property of all with eyes to observe and imagination to contemplate its wonders. Thus our satellite has been an important inspiration to artists, poets, novelists, and playwrights.

Many recall with delight how artfully Edmond Rostand wove the moon into the scene of the romantic play, *Cyrano de Bergerac.* The redoubtable Cyrano, in an effort to delay the somewhat dull-witted De Guiche, springs to the ground from the overhanging limb of a tree and purports to have just landed from the moon!

De Guiche: What? What is this? Where did this man fall from?
Cyrano: From the moon!
De Guiche: From the what?
Cyrano: (in a sleepy voice) What time is it?
De Guiche: Has he lost his reason?
Cyrano: What time is it? What country? What day? What season?
De Guiche: But ———
Cyrano: I fell like a bomb from the moon!
De Guiche: (out of patience) Ah! Come now, sir!
Cyrano: (rising, in a terrible voice) I fell from it!
De Guiche: (drawing back) Well! Let it be so! You fell from it! Perhaps he is demented!
Cyrano: (stepping toward him) And I didn't fall metaphorically!
De Guiche: But ———
Cyrano: A hundred years, or perhaps one minute ago — I have no idea how long my fall lasted! — I was in that saffron-colored orb!

And later in the same scene Cyrano exclaims: "I have arrived — excuse me — by the last cloud-burst. I am somewhat covered with ether. I have had a journey of it! My eyes are filled with star dust. I still have some planet fur on my spurs. Wait, here is a comet's hair on my doublet!"

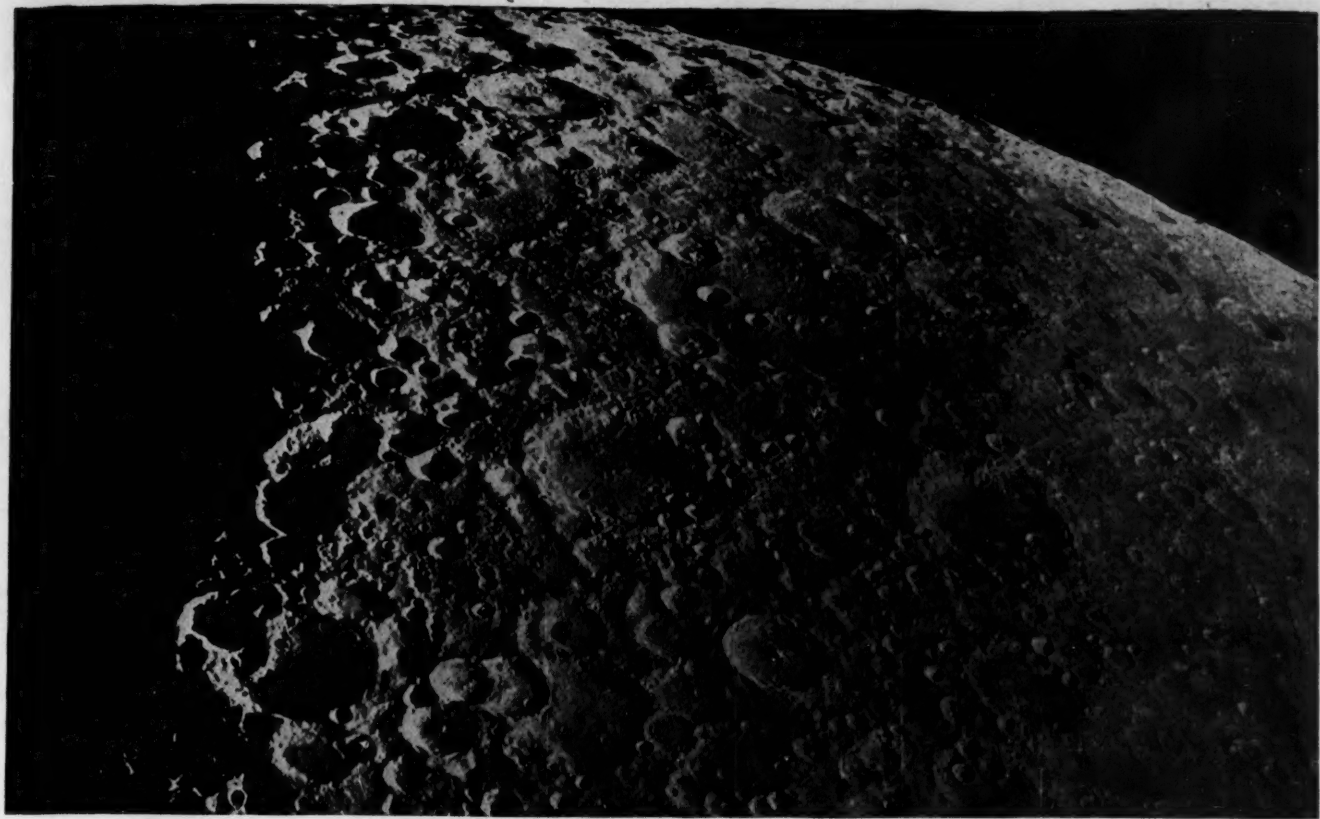
In the field of scientific fiction, both Jules Verne and H. G. Wells found the moon to be ample inspiration for great novels. These contributions to drama and fiction are accepted even today as examples of the best in imaginative writing. But all writers have not been inspired in the same way.

On August 25, 1835, an announcement of sensational interest appeared on the front page of *The Sun,* a New York daily paper. It told of recent amazing discoveries that had been made by Sir John Herschel through a new mammoth telescope that he had put into operation at the Cape of Good Hope. This article, and several that followed on succeeding days, described in detail how he had brought the moon (visually) to within 40 miles of the earth and, using a magnification of 6,000 diameters, had actually witnessed lunar cities that were populated by weird human-like creatures equipped with bat-like wings. The detailed topography of the moon was described, even to the color of the cliffs and oceans.

Altogether it was the greatest revelation that the world had ever known, with a sufficient sprinkling of technical language to impress even some astronomers. But the request for certain facts and figures which were said to have been deleted because of their technical nature led to the finding that a clever young reporter had cooked it all up as a means of boosting circulation and, incidentally, improving his own reputation.

Another interesting story involves a lunar eclipse and Columbus. The date was February 29, 1504, during Columbus' fourth voyage to the New World. He and his men were stranded in the West Indies, their ships in bad shape and provisions low. Certain of his crew had turned against him, and even the Indians would not bring food. Columbus' astronomical tables told of a lunar eclipse that would occur that night, and he threatened to destroy the light of the moon as a just punishment for their neglect. At the appointed moment, the copper shadow of the earth began to creep ominously across the face of the moon! On Columbus' promise to restore to life the goddess of the night sky, the Indians brought an abundance of game and fruits to the Spaniards.

In popular superstition even today the



The southern portion of the moon at last quarter. Photograph by the 100-inch telescope at Mount Wilson Observatory.

moon occupies a prominent and important place. In addition to the various schools of thought concerning the so-called wet and dry moons, there is the belief that we will surely have a change in weather when the moon changes phase. The best answer to this is in the verse:

The moon and the weather
May change together;
But the change of the moon
Does not change the weather.

If we'd no moon at all
(And that may seem strange)
We still should have weather
That's subject to change.

There are a score or more of theories concerning the best lunar aspect for catching fish, some of them with scientific foundation. Many who live along the seacoast are convinced that the fish bite best when the moon is at or near perigee. Many farmers are quite sure that their corn will flourish best if planted in the dark of the moon. Others are certain that killing frosts occur at the time of full moon, and experienced scientists are hard put to convince the natives of a region that such a cause-and-effect relation does not exist.

With the recent increased experimentation on rockets and guided missiles, there has been much speculation on the possibility of some day sending a rocket to the moon. In planetariums the trip to the moon lecture always attracts large audiences. The recent experiment of transmitting radar pulses to the moon and receiving the echo stimulated great popular interest, and the moon has even appeared under high power on the television screen.

Certainly we must admit that our satellite plays an important part in the history of civilization, and it may take on added importance in the future.

IN FOCUS

(Continued from page 218)

cage, on the back cover this month, is the fourth in our series of these famous sketches. The upper portion of the cage appeared in May, showing the same plateholder and guiding microscope which may be seen in the upper right of this picture. Below the plateholder is a special correcting lens which increases the size of the usable field when an extended object or a number of objects are to be recorded. On the wall of the observing cone is a larger, supplementary corrector.

Two of the main auxiliary mirrors are shown, one in place as actually used, and the other folded up against the cage wall to show how the mirrors are positioned when not in operation. The motors and eccentric cams above the lowered Cassegrainian mirror are those for lowering and raising the secondaries. To keep the instrument in perfect balance at all times it is necessary to redistribute the weight change caused by changing secondaries. The motor at the left on the bottom ring drives a large spur gear to position special lead weights; one of these weights may be seen (labeled "lead") below the pivot of the secondary that is in operating position. To interchange secondary mirrors takes about 10 minutes.

The secondary mirror which is upright against the side of the cage shows the eight-section mirror cover. Some idea of the various mirror sizes and parts can be surmised from the six-foot diameter of the prime-focus cage. The Cassegrainian focal length is 266 2/3 feet and the coude focus is 500 feet, respectively f/16 and f/30.

ASTRONOMICAL SOCIETY OF MEXICO

(Continued from page 224)

tional side we had double stars, the Orion nebula, Saturn's rings, and the satellites of Jupiter.

Today, people above college age expect some quite different things from a lecturer in astronomy. Due mainly to Eddington's books they want to hear all about relativity, and no longer have a taste for the straightforward and unambiguous Newtonian panorama of the universe. They prefer the metaphysical paradox, the scientific uncertainty, an attitude which makes the task of the lecturer much more difficult. Nor is the situation easier at the telescope, where people expect, in the field of a 12-inch reflector, to see galaxies with the same detail as is shown in the pictures so widely published from the long-exposure plates of Lick and Mount Wilson observatories. And many are so uninitiated as to expect the rotation of these objects to be clearly perceptible at a glance. In some respects, the lantern-slide projector is today the most useful and reliable tool for the diffusion of astronomical knowledge.

BOOKS AND THE SKY

THE GROWTH OF PHYSICAL SCIENCE

Sir James Jeans. Cambridge University Press, Macmillan, New York, 1948. 364 pages. $4.00.

IN THE PREFACE of this last book by Sir James Jeans, the purpose is stated to be "to describe the main lines of advance of physical science, including astronomy and mathematics, . . . in language non-technical enough to be understood by readers who have no scientific attainments or knowledge." Evidently the author was stimulated by the same considerations that have caused leading educators to urge a renewed interest in the history of science. If modern science is surveyed against a background of and as a necessary growth from classical doctrines, the reader gains a convincing impression of the essential unity of method that produced forward strides in any century.

With broad knowledge of both theoretical physics and astrophysics, the author was particularly well equipped to deal with the modern phases of the growth of physical science. Less expected to many readers may be the authority with which he deals with the beginnings in the distant past. Perhaps too many have, on no very sound basis, placed Greek science higher than it merits. A summary of conditions at the destruction of what remained of the library at Alexandria in 642 removes this misunderstanding (page 103), if the preceding chapters had left any doubts: "Geometry, which had made such magnificent progress at first, came to a dead end; algebra had hardly yet arrived; physics, which had made a good start, had been strangled almost at birth; astronomy, after making the best of starts, had taken a wrong turning at the time of Aristarchus, and was now advancing along the wrong road." Clearly, more than restoration of Greek science was needed after the Dark Ages.

The book may be divided into three nearly equal parts: Chapters I to IV, science to the end of the Dark Ages; Chapters V and VI, the beginning of modern science through Newton; Chapters VII and VIII, the two centuries after Newton and the era of modern physics. This may or may not represent a deliberately planned balance. Even if the modern period seems foreshortened in comparison with the more leisurely treatment of the earlier centuries, the later chapters are remarkably rich in content.

Astronomy occupies a prominent place in every period. It is heart warming to read Jeans' unreserved acknowledgment of Eddington's epoch-making work on stellar interiors. Equally fair is the last page of the book which covers Eddington's attempt to establish a synthesis of the physics of the infinitely great and the physics of the infinitely small. This leads to the final paragraph:

"Few, if any, of Eddington's colleagues accepted his views in their entirety; indeed few if any claimed to understand them. But his general train of thought does not seem unreasonable in itself, and it seems likely that some such vast synthesis may in time explain the nature of the world we live in, even though the time may not be yet."

DIRK BROUWER
Yale University Observatory

CAUSES OF CATASTROPHE

L. Don Leet. Whittlesey House, New York, 1948. 232 pages. $3.00.

OUT OF THE CATASTROPHES which descend upon the human race the author has selected four chief disturbers — earthquakes, volcanoes, tidal waves, and hurricanes. To each he allots a chapter. There are other chapters: an introductory one entitled "Culmination of Catastrophe," which gives a brief and vivid account of the 1923 earthquake in Japan; two chapters on mountain making; and a final brief discussion of "Geophysical Fables."

In the inscription on the jacket the publisher promises that "Anyone who has asked 'Why?' when nature's sudden furies descend, will find in **Causes of Catastrophe** a vast accumulation of facts which will enable him to understand the natural forces lying behind the newspaper headline announcing an earthquake, tidal wave, volcano, or hurricane." But the author is not so optimistic. He presents facts, surmises, and doubts judiciously, making clear what is known and not known. In the end, it is evident that our knowledge of these forces of nature is limited; thus the causes of the selected and described catastrophes are in many cases relatively obscure. Therefore, perhaps the salient feature of the book turns out to be the description of important catastrophes of the sea and of the air, and the recorded violent disturbances of the earth's crust. These descriptions are skillfully selected; they are brief and memorable, and even those who have read previous accounts of the same calamities will want to read them carefully.

Earthquakes are taken up first, and the San Francisco disaster of 1906 is reviewed. Here we have a heading on "Modern Information on Causes and Effects of Earthquakes." In accordance with the universal finding of investigators, the California earthquake in question is ascribed to movement along the San Andreas fault — it was the fault-slip that caused the quake. The coincidence of the activity of the fault and the earthquake was certainly striking, and the stated conclusion natural, but was the evidence really conclusive? Did the fault-slip cause the quake, or was it one of the

NEW BOOKS RECEIVED

PICTORIAL ASTRONOMY, *Alter* and *Cleminshaw*, 1948, *Griffith Observatory*. 288 pages. $3.00.

This is an elementary book suitable as a text for the layman or at high-school level, copiously illustrated, and written by the director and associate director of the Griffith Observatory and Planetarium.

ASTRONOMY, *William Lee Kennon*, 1948, *Ginn*. 737 pages. $5.50.

The author of this new textbook is professor of physics and astronomy at the University of Mississippi. The text is designed particularly for college use.

results of the quake? In the city, statues were slid off their pedestals; the sliding planes were technically faults, and similar technical faults abounded.

Faults in rocks are exceedingly commonplace. One who has made much study of faults, underground, in mines, in regions not especially subject to earthquakes, may naturally question whether faults are in the habit of producing quakes. Their general role, indeed, is the opposite. They are sliding planes; they ease and accommodate rock strains. Is it not possible that the San Andreas slip acted as a palliative, without which the earthquake in the city would have been worse? Therefore, in the San Francisco case, is it not fundamental to inquire what caused this sudden fault activity (together with the other phenomena of the catastrophe)? And this inquiry is awkward, for we do not know the answer. It is doubly awkward, for on the San Francisco case much theory has been based concerning the origin of earthquakes in Japan, even in New England; and therefore on faulting as the cause of earthquakes in general. But it may perhaps be agreed that a fault does not of itself produce an earth vibration: the prime mover and cause is the force impinging on the rock. Such stresses, indeed, the author appeals to throughout the book as causal agents: "the urge of unseen, unexplained internal forces."

As to foreknowledge, the author makes a comprehensive statement: "Never predict anything about earthquakes." And he cites instances showing how unlucky have been prophets who tried.

The book provides a great amount of information on matters which are easily led up to by the chosen subject, but which have a rather remote connection with it, such as glaciation, the origin of mountains, even the location of the roots of buried ancient mountains whose accompanying catastrophes, if there were any, are lost in oblivion. As an extreme wandering, the moon is touched upon; and from the reviewer's prejudiced standpoint (for he has written about the moon) this inclusion is not only not germane to the discussion, but the cited material is casually selected, and archaic. For example, the conspicuous "rays" around certain great lunar craters are thus noted:

"One description says: 'They look as if, after the whole surface of the moon had assumed its final configuration, a vast brush had been drawn over the globe in straight lines, radiating from a central point, leaving its trail upon everything it touched, but obscuring nothing.' It has been suggested that these streaks are dikes of intruded matter which reflects the sunlight more effectively than the surrounding rock."

To any geologist, the theory in the last sentence should be prohibited by the description in the first. And the illustration of a moonscape, after a drawing, is certainly exaggerated, and fanciful in various respects. The moon has become one of the last refuges of fancy.

In general, the book has been compiled with keen judgment, and the results are set forth clearly, in plain and spirited language. The committee to whom the manuscript was submitted was amply warranted in choosing it for honorable mention in the recent science-for-the-layman Whittlesey House-**Science Illustrated** fellowship contest.

J. E. SPURR
Alstead, N. H.

GLEANINGS FOR A. T. M.s

THE COMPOUND REFLECTING TELESCOPE — III

By Allyn J. Thompson

A delicately accurate, acceptable test, made at the focus of a paraboloidal mirror, is illustrated in Fig. 10. Rays from the pinhole are reflected as parallel light from the primary mirror to an aluminized plane mirror, from which they are returned still parallel, just as if they had come from a star. (A well-figured parabolic mirror may be used instead of a flat to produce parallel rays of light from a pinhole placed at its focus.) The parallel rays are then converged by the paraboloidal primary to form an image of the pinhole at its focus. The shadow appearance when applying the knife-edge is the same as in testing a spherical mirror at its center of curvature, and by this method the primary can be corrected to a degree of precision corresponding to that of the plane mirror. If the latter is flat to 1/10 of a wave length, a practically perfect paraboloid will result.

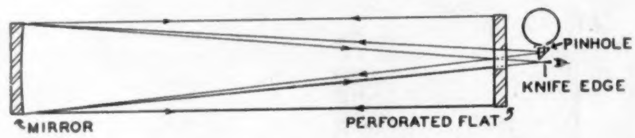


Fig. 10. Testing a paraboloid at its focus with an optical flat.

The Dall Null Test. What should prove a very versatile test, applicable to hyperboloidal and ellipsoidal primaries as well as to the paraboloid, has recently been devised by Dall. It was described in this department in the April, 1948, issue of **Sky and Telescope,** where diagrams and tables from the original article in the **Journal** of the British Astronomical Association were reproduced. As it is a null test, with perfection in any of these three primary mirror figures discernible without special interpretation of shadow appearances, it should make possible much more accurate figuring than can be done with the ordinary Foucault test.

The new test requires an extremely bright light source, a filter, and a plano-convex lens of suitable characteristics to be used in connection with the usual Foucault apparatus. When the lens is set a precomputed amount (intercept distance) in front of the mirror's center of curvature, the aberration of the lens counterbalances or corrects that of the paraboloid (r^2/R). The apparent surface under test is then seen to darken uniformly as the knife-edge is cut in, just as though it were a sphere.

The advantages of this test may fortunately be applied to the undercorrected mirror which we wish to use in our Dall-Kirkham telescope. The aberration of such a mirror at the knife-edge is of course less than the value of r^2/R, which is used in determining the focal length of the correcting lens, but by moving the latter closer to the center of curvature, its aberration will be lessened. The percentage of undercorrection gives a direct measure of the amount by which the lens should be shifted from the calculated intercept distance. (To be useful on the hyperboloidal primary for the modified Gregorian telescope, the percentage of overcorrection would first have to be known.)

In practice, the characteristics of both primary mirror and correcting lens determine the intercept distance. One fourth of the percentage of undercorrection (one fourth of 21.7 per cent in our 6-inch f/3.4) is the percentage by which the intercept distance is decreased for the null test.

The hyperboloidal secondary can be independently tested by a method described by John A. Hindle in **Amateur Telescope Making,** utilizing for the purpose an aluminized and perforated spherical mirror. The radius of curvature of the test mirror should be somewhat shorter than the focal length of the primary if all of the secondary's surface is to be tested. The test is illustrated in Fig. 11, where **S** is the secondary mirror, **M** the spherical test mirror, and **P** the relative position of the paraboloidal primary mirror in the tele-

EDITED BY EARLE B. BROWN

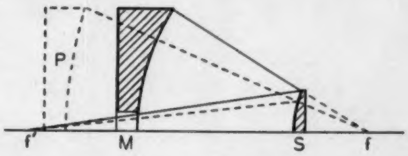


Fig. 11. Testing a hyperboloidal secondary with a spherical mirror.

scope. Divergent rays of light from a pinhole source at **f'** are reflected from the hyperboloidal secondary as though they had proceeded from its virtual focus **f**. As **f** is coincidentally the center of curvature of the test mirror, the rays strike its surface perpendicularly, and thus will be returned along identical paths to a focus at **f'**. A scale drawing will determine the radius of curvature to be given the test mirror. An advantage of this test is that the whole of the secondary's surface, except of course a small central area, can be examined under the knife-edge.

Correction of the secondary is obviously limited to the precision of the test mirror, which on account of the low order of knife-edge sensitivity with such short focal lengths, may depart from the sphere by ¼ of a wave length or more. If the primary mirror is a perfect paraboloid, however, the figure of the secondary may differ from a hyperboloid by the above amount without perceptibly impairing the image, so it is possible to correct the secondary satisfactorily by this method.

But since an optically flat mirror is necessary for production of a perfect paraboloid, the flat can also be utilized to test the secondary in combination with its primary in the manner shown in Fig. 12, thus dispensing with the making of an otherwise useless spherical test mirror. A pinhole light source and a knife-edge, both placed back of the perforated primary mirror, in the plane of the secondary focus, are the instruments of testing. Di-

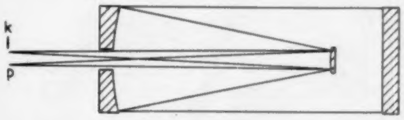


Fig. 12. Testing a compound telescope at focus with an optical flat.

vergent rays from the pinhole are reflected from the secondary to the primary, and if the mirrors are each without aberration, or if they compensate each other's axial aberrations, parallel rays will be reflected from the primary to the flat, from which they return still parallel, to be brought to a perfect focus at the knife-edge. When the latter is cut into the image, the secondary mirror, or the reflection of the primary mirror seen in it, will darken instantly just as does a spherical mirror when tested at its center of curvature. If undercorrection is present, the apparent cross section of the mirror will be like that at **a** or **a'**, Fig. 13. Overcorrection will present the cross section shown at **b**.

If the primary mirror is not perforated,

a prism or an aluminized plane diagonal can be placed between it and the secondary, and the pinhole and knife-edge moved around to the side. Because there are five or more reflections, the flat and either the primary or the secondary mirror (whichever is not being corrected) must be aluminized. As use of the optical flat approximately doubles any aberrations, this method offers the best chance for perfect correction.

On account of the multiple reflections, the knife-edge and pinhole must be in the closest possible proximity. Even with a

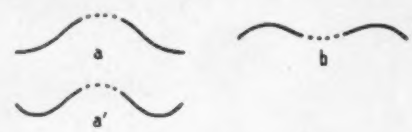


Fig. 13. Apparent cross sections in tests at the focus of a compound telescope.

very small separation the astigmatic effect on the shadow appearances is aggravatingly severe. Both pinhole and knife-edge should, if possible, be on the mutual axis of the system of mirrors, and this can be accomplished with use of a semitransparent diagonal mirror or "beam-splitter." This accessory consists of a small rectangle of thin (about 1/16") optically flat glass, which is half-silvered or half-aluminized (Duolux) on one surface. The setup for testing is shown in Fig. 14, where the thinly aluminized diagonal is used to deflect light from the pinhole to the secondary. The returning beam retraces its original path, except that nearly half of it passes through the beam-splitter to come to a focus in back of it, where the pinhole image is engaged by the knife-edge.

It is generally thought that testing with an optical flat is inconclusive, as theoretically only that portion of the secondary which is engaged in axial image formation comes under scrutiny. The diameter of this area can be found from

$$d' = Ap/F, \qquad (2)$$

where **A** is the aperture of the primary mirror; **F** is its focal length; and **p** has the meaning shown in Fig. 3. In the test of Fig. 12, it is evident that both pinhole and knife-edge are off-axis; thus all effective zones of the secondary can be brought into

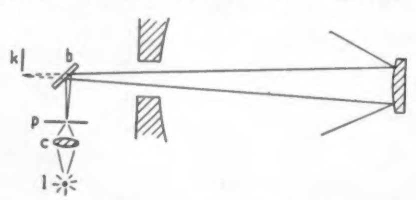


Fig. 14. Testing on axis with a beam-splitter. The light source is l; c, a condensing lens; p, the illuminated pinhole; b, a semitransparent front-surface mirror; k, the knife-edge.

action. In using the beam-splitter, the pinhole or telescope can be shifted slightly, and the quality of the off-axis image is then tested.

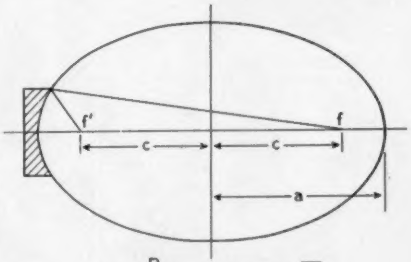
When the spherical or nearly spherical secondary is tried in conjunction with the spherical test mirror, or with the paraboloidal primary under parallel light, the

Fig. 15. A test for an ellipsoidal mirror.

overcorrected condition shown in Fig. 6 is obtained, and its apparent shape is as at **b**, Fig. 13.

What has been said about the probable error in testing the paraboloidal mirror at its center of curvature applies as well to the undercorrected or ellipsoidal mirror. Since testing errors of similar magnitude must be allowed for here, it cannot be anticipated that the Dall-Kirkham telescope will be free of aberration. I recently made as an experiment two such telescopes, each containing a 6-inch f/3.5 primary mirror, and spherical secondaries amplifying six times. Although the primary mirrors had apparently identical figures, the aberration in one telescope amounted to about 1/32", whereas in the other it was nearly 3/16". One telescope was therefore quite perfectly corrected, its aberration being well within the tolerance given in Table I, but the second one exceeded the permissible limit by nearly 2½ times. The error in its primary mirror, evidently amounting to about 0.02" at center of curvature, went undiscovered under the Foucault test, thus further substantiating the writer's opinion that errors of this magnitude cannot positively be eliminated by this method of testing.

It has been suggested by Dall, Kirkham, and others, that the undercorrected primary can be tested by the same method that is used on a Gregorian's ellipsoidal secondary mirror. If, for example, a pinhole source of light is placed at one focus of the ellipsoid (Fig. 15) and the knife-edge is cut into the reflected image at the other focus, the shadow behavior should be similar to that on a spherical mirror tested at its center of curvature. Formulae for very nearly locating these foci are given in Fig. 16, where **R** is the radius of curvature of the primary mirror, **N** the



$$a = \frac{R}{1-N} \qquad c = a\sqrt{N}$$

Fig. 16. Locations of the foci of the ellipsoidal mirror.

fractional correction given by formula (1), and **a** and **c** have the meanings shown in the diagram. Where there is sufficient room to carry on this test, it may prove more feasible to put the light source at **f**, with a diagonal to bring the reflected beam to the side at **f'**. This arrangement has the advantage of providing a closeup view of the mirror's figure.

(To be continued)

OBSERVER'S PAGE

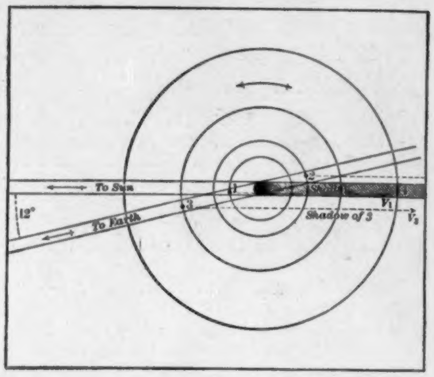
Greenwich civil time is used unless otherwise noted.

JUPITER'S SATELLITES

On two nights during July the four Galilean satellites of Jupiter will present rare configurations. All four will be invisible or extremely close to the planet, as viewed from the United States and Canada. On July 3-4, with the aid of a telescope, these events may be seen from 3:13 to 7:39 GCT: Satellite **I** will be in occultation from 4:59 to 7:39; **II** transits from 3:13 to 5:46 (its shadow from 4:06 to 6:41). The brightest moon, Ganymede, **III**, is in eclipse as Jupiter rises, and makes its reappearance at 4:26, while the faintest of the four, Callisto, **IV**, is at inferior conjunction a few seconds of arc north of the planet. This last-mentioned moon will be visible only in a large telescope. Therefore, at about midnight Eastern standard time, Jupiter will appear almost bereft of satellites.

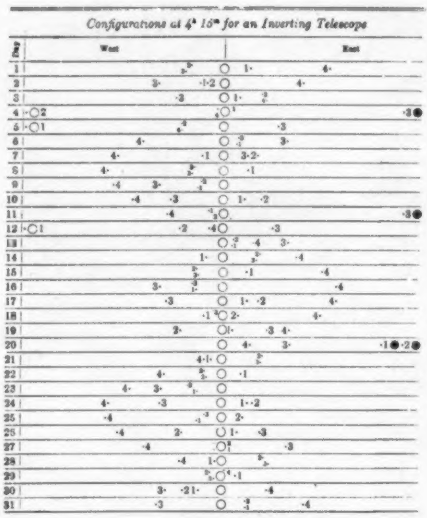
The four satellites will again be unusually placed on July 28-29. Io, the first satellite, is in eclipse as Jupiter rises, and reappears at 2:19. Europa is eclipsed from 1:50, not appearing again that night. **III** transits from 23:45 to 2:32, and the shadow will cross the disk of Jupiter from 3:30 to 6:25. Callisto comes to superior conjunction at about 3:00, just off the south edge of the planet. At 9:00 p.m., EST, Jupiter will once more appear as if unattended by any satellites.

EDWARD ORAVEC



A diagram to illustrate phenomena of Jupiter's satellites (at time of quadrature with the sun): 1. shadow transit; 2. occultation; 3. transit; 4. eclipse. From "Astronomy," by Russell, Dugan and Stewart.

Jupiter's four bright moons have the positions shown below for the GCT given. The motion of each satellite is from the dot to the number designating it. Transits of satellites over Jupiter's disk are shown by open circles at the left, and eclipses and occultations by black disks at the right. Reproduced from the **American Ephemeris and Nautical Almanac.**



VARIABLE STAR MAXIMA

July 2, U Ceti, 7.5, 0228**13**; 9, RS Librae, 7.7, 1518**22**; 11, RR Sagittarii, 6.6, 1949**29**; 12, R Serpentis, 6.8, 154615; 13, R Carinae, 4.6, 0929**62**; 13, R Canum Venaticorum, 7.7, 134440a; 13, T Normae, 7.4, 1536**54**; 15, S Hydrae, 7.9, 084803; 19, R Aquarii, 7.3, 2338**15**; 19, R Phoenicis, 7.8, 2351**50**; 23, T Centauri, 6.1, 1336**33**; 23, Chi Cygni, 5.3, 194632; 27, S Pavonis, 7.3, 1946**59**; 27, RU Sagittarii, 7.2, 1951**42**.

These predictions of variable star maxima are made by Leon Campbell, recorder of the AAVSO, Harvard College Observatory, Cambridge 38, Mass. Serious-minded observers interested in making regular telescopic observations of variable stars may write to Mr. Campbell for further information.

Only stars are included here whose mean maximum magnitudes, as recently deduced from a discussion of nearly 400 long-period variables, are brighter than magnitude 8.0 Some of these stars, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the predicted magnitude, and the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern).

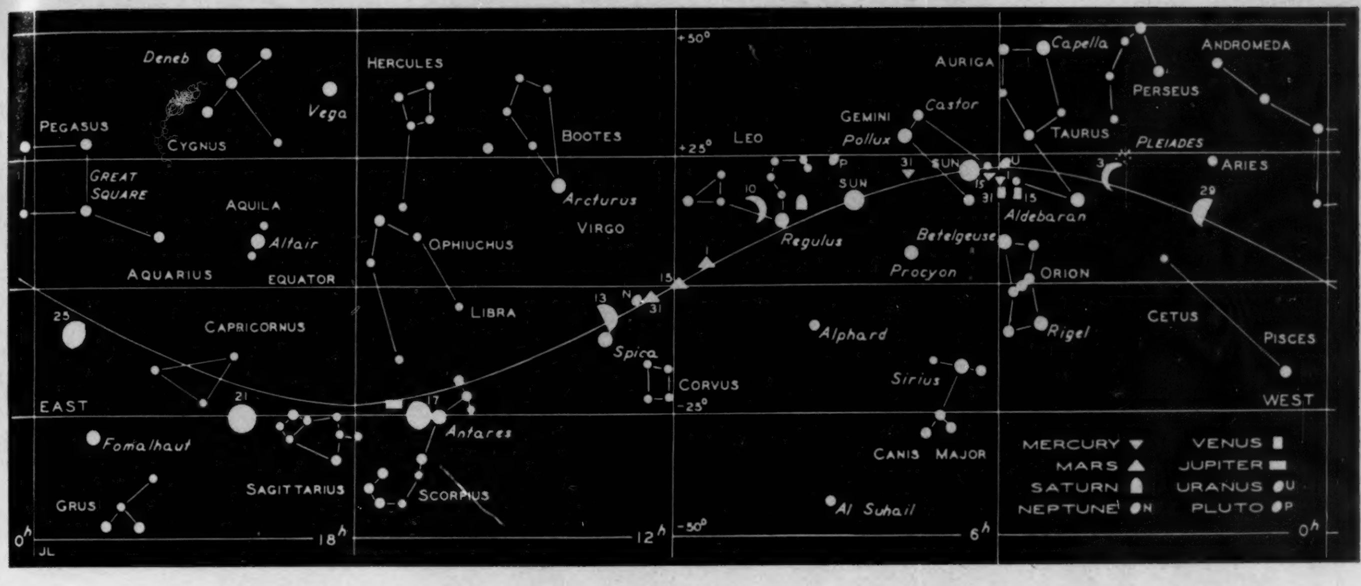
GREENWICH CIVIL TIME (GCT)

TIMES used on the Observer's Page are Greenwich civil or universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the GCT before subtracting, and the result is your standard time on the day preceding the Greenwich date shown.

METEORS

The first of the two major summer meteor showers, the Delta Aquarids, may be observed the latter half of July. Maximum rates will be seen about the 28th and to a lesser extent from the 25th to the 31st. The radiant rises early in the evening and culminates at 2 a.m. local time. A last-quarter moon will interfere as it is in the Pisces-Aries region. The Delta Aquarids are usually bright, yellow, and not too swift. Occasionally meteors with long paths will be seen. Rates of 20 to 30 per hour are predicted, and in 1947 the writer confirmed this by observations in Guam. On three nights, the average was 23 per hour, and up to 32 in one hour were recorded.

The Perseid meteor shower begins the last week in July, so that some swift meteors should be seen at the time of the Delta Aquarids. E. O.



THE SUN, MOON, AND PLANETS THIS MONTH

The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month and for other dates shown.

Mercury, a morning object, reaches western elongation on July 16th, 20° 33′ west of the sun. On that date, the planet will be of magnitude +0.6 and will rise 1½ hours before the sun. It should easily be possible to follow Mercury for a week after elongation.

Venus emerges as a morning star about July 1st, rising some 30 minutes before the sun. It rapidly moves from the region of the sun and reaches greatest brilliance on the 31st, magnitude −4.2.

Mars travels through western Virgo during July. The ruddy planet steadily decreases in brightness. The middle of July finds it setting almost due west some three hours after the sun.

Jupiter continues its retrograde motion, in excellent observing position, about 13° east of Antares. Its disk is about 45″ in diameter; its magnitude is −2.1. The accompanying note tells of several unusual configurations of its satellites.

Saturn, west of Regulus, disappears in the twilight by the end of the month.

Uranus, in the morning sky, is too near the sun to be seen easily.

Neptune. With optical aid, this planet may be found 1½° south of Gamma Virginis, and on the 31st it is 13′.4 south of 7th-magnitude 298B Virginis.

E.O.

CORRECTION

In the report "Sunset Eclipse in the Northwest," May **Sky and Telescope,** page 188, the third sentence of the third paragraph should read: "Here, using overexposed photographic film to view the sun, . . . the semblance of the **moon** to a flat disk changed to a rounded fullness. . . . "

PHASES OF THE MOON

New moon	July 6,	21:09
First quarter	July 13,	11:30
Full moon	July 21,	2:31
Last quarter	July 29,	6:11
New moon	August 5,	4:13

OCCULTATION PREDICTIONS

July 16-17 **22 Scorpii** 4.9, 16:27.0 −25-00.1, 10, Im: **A** 2:46.3 −1.9 −0.8 108; **B** 2:42.0 −1.8 −0.7 105; **C** 2:40.1 −2.1 −0.8 115; **D** 2:32.0 −1.9 −0.5 110; **E** 2:13.2 −1.6 −0.5 127; **F** 2:14.8 −0.7 −2.0 161.

22-23 **161 B Capricorni** 6.4, 21:59.3 −18-09.2, 16, Em: **E** 11:04.6 +0.3 +1.7 190; **F** 10:39.3 ... ... 161; **H** 10:38.6 −1.8 +0.7 236; **I** 10:35.3 −1.9 −0.2 266.

30-31 **A Tauri** 4.5, 4:01.6 +21-56.5, 24, Im: **A** 6:27.5 +0.2 +1.6 63; **B** 6:32.7 +0.2 +1.7 58; **C** 6:22.9 +0.3 +1.5 64; **D** 6:31.2 +0.3 +1.6 55. Em: **A** 7:24.5 −0.2 +1.7 249; **B** 7:29.2 −0.3 +1.6 255; **C** 7:18.2 −0.1 +1.6 249; **D** 7:25.1 −0.1 +1.5 259.

30-31 **39 Tauri** 6.0, 4:02.3 +21-52.2, 24, Em: **A** 7:33.7 +0.1 +2.1 221; **B** 7:39.9 0.0 +2.0 227; **C** 7:27.0 +0.2 +2.0 221; **D** 7:36.4 +0.1 +1.9 231; **E** 7:32.1 +0.3 +1.6 239.

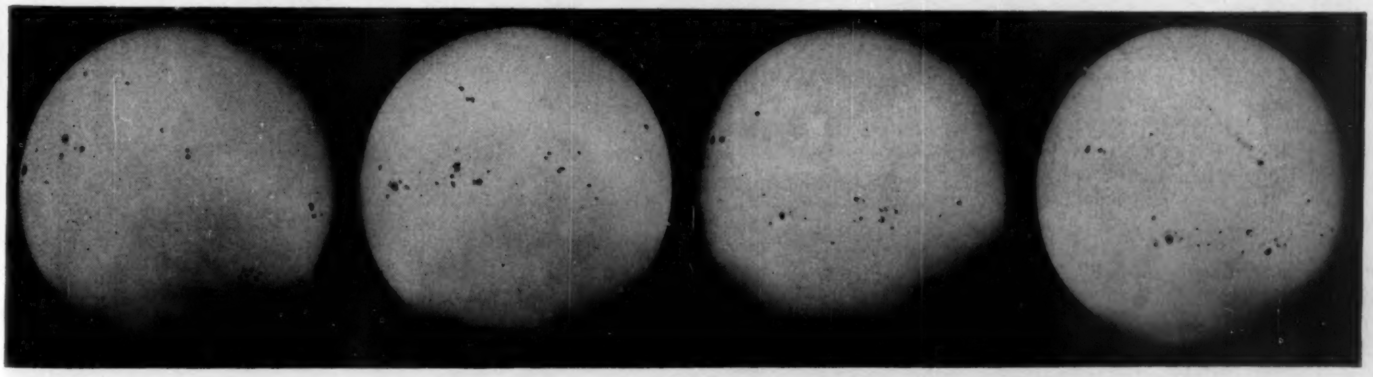
For selected occultations visible at standard stations in the United States and Canada under fairly favorable conditions, these predictions give: evening-morning date, star name, magnitude, right ascension in hours and minutes and declination in degrees and minutes, moon's age in days, immersion or emersion; standard station designation, GCT, a and b quantities in minutes, position angle; the same data for each standard station westward.

Longitudes and latitudes of standard stations are:

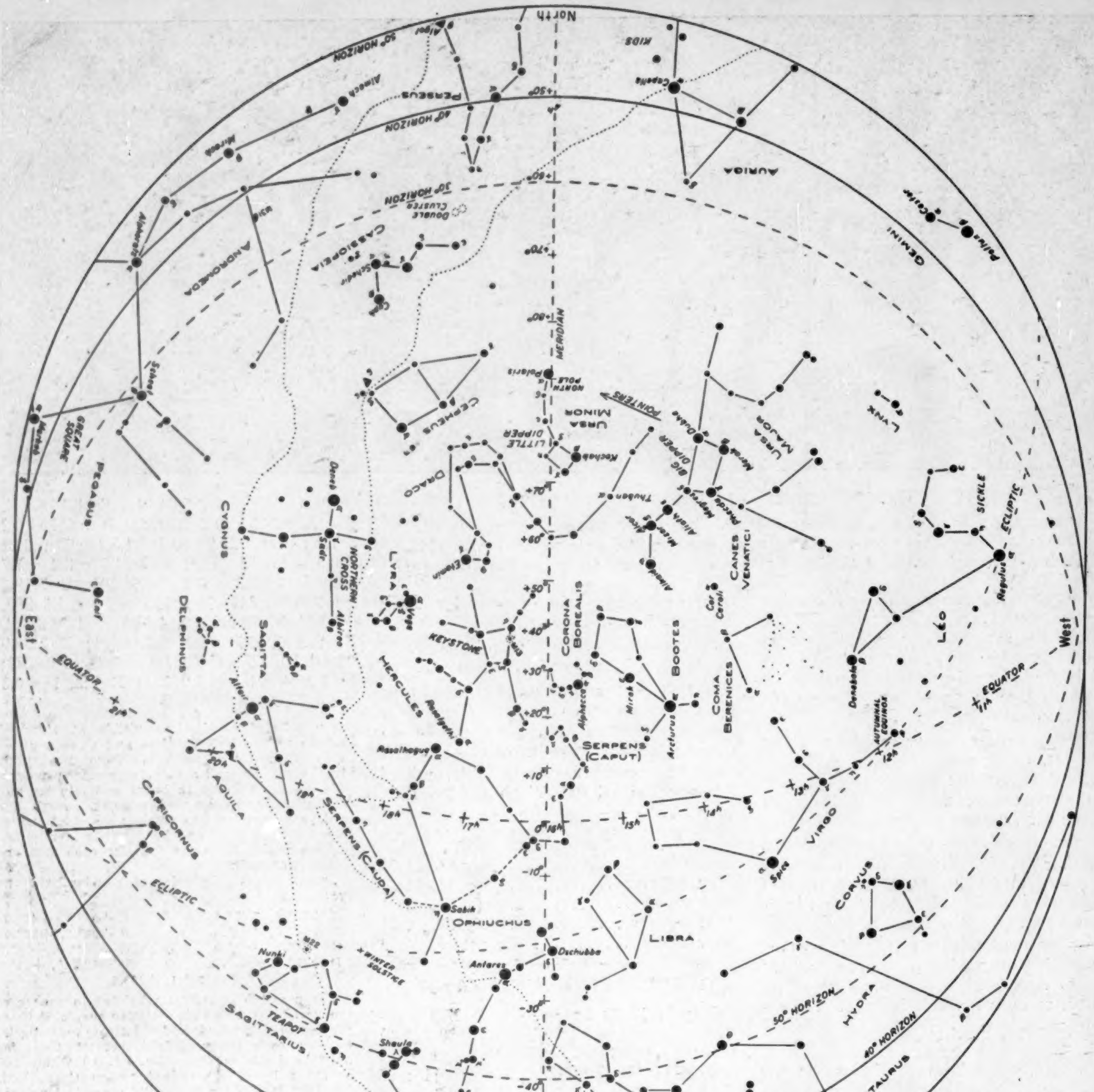
A +72°.5, +42°.5	**E** +91°.0, +40°.0
B +73°.6, +45°.6	**F** +98°.0, +30°.0
C +77°.1, +38°.9	**G** +114°.0, +50°.9
D +79°.4, +43°.7	**H** +120°.0, +36°.0

I +123°.1, +49°.5

The a and b quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude respectively, enabling computation of fairly accurate times for one's local station (long. Lo, lat. L) within 200 or 300 miles of a standard station (long. LoS, lat. LS). Multiply a by the difference in longitude (Lo — LoS), and multiply b by the difference in latitude (L — LS), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Greenwich civil time to your own standard time.



Activity on the sun during a week in May. These pictures were taken on May 6, 11:42 a.m. EST; May 8, 11:43 a.m.; May 10, 1:22 p.m.; May 12, 9:30 a.m. Photographs by Rev. W. M. Kearons, West Bridgewater, Mass.



DEEP-SKY WONDERS

ONLY ABOUT 100 globular clusters are known in our galaxy, and the probabilities of finding more are scanty. These globular clusters range in diameter from 23′ (Omega Centauri and 47 Tucanae) to about 0′.4. Integrated magnitudes range from 3 to 12.6. Consequently, large amateur telescopes should reach the majority of these objects, and they should be recognized without error.

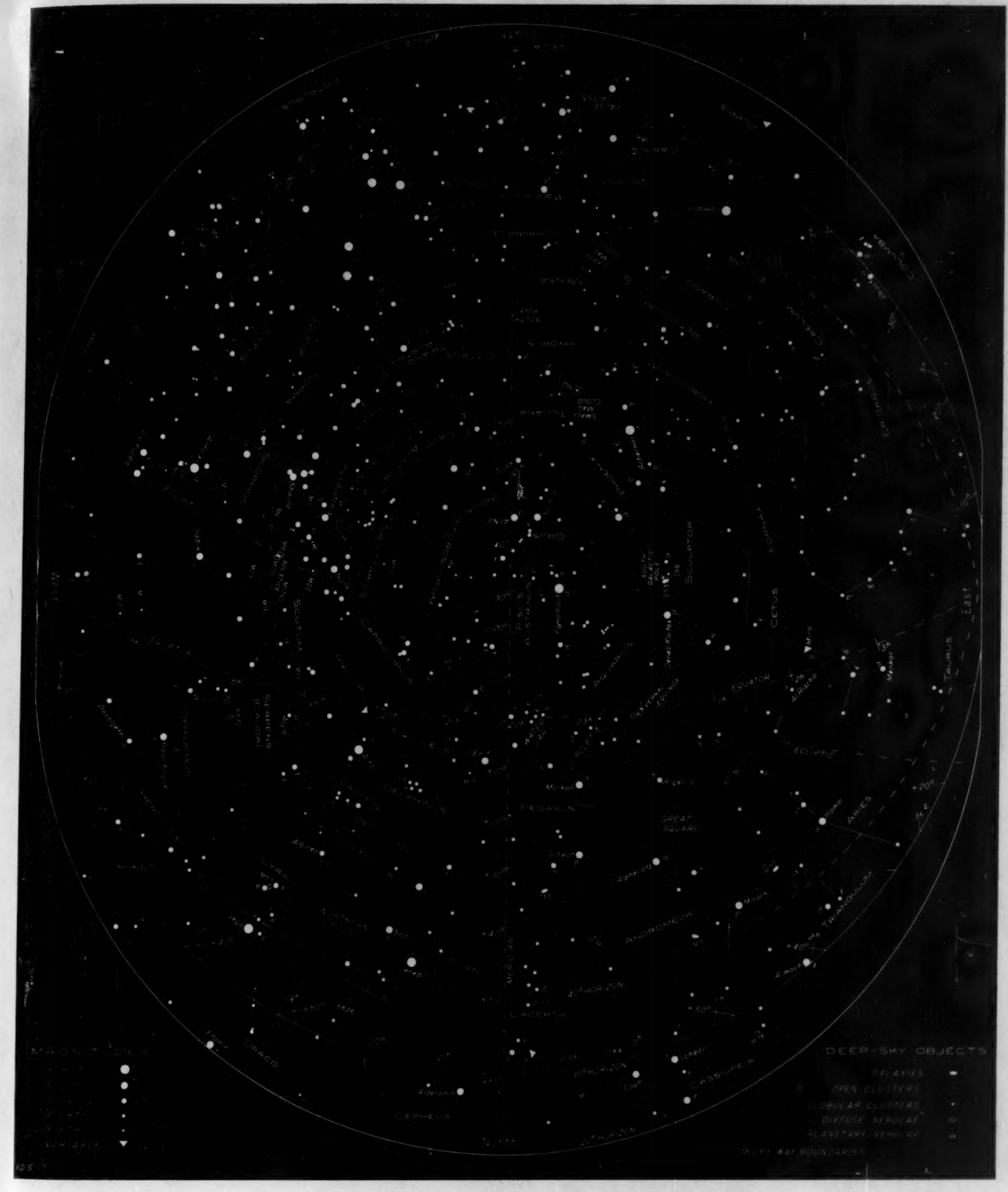
The following three globulars were all within reach of Herschel's instruments although neither Admiral Smyth nor the Reverend Webb comments on them. They require some care in finding as the region is thick with star clouds, nebulae, and faint stars. **NGC 6284,** 11^6, $17^h\ 1^m.4$, −24° 32′.7, dia. 1′.5, mag. 10.0, distance 28 kiloparsecs. **NGC 6287,** 195^2, $17^h\ 2^m.1$, −22° 30′, dia. 1′.7, mag. 10.4, 28 kiloparsecs. **NGC 6293,** 12^6, $17^h\ 7^m$, −26° 21′.7, dia. 1′.9, mag. 8.8, 23 kiloparsecs.

These are near the more familiar **NGC 6273,** M19 (see Deep-sky Wonders, July, 1944, and July, 1946), which richly deserves Smyth's comment, "The above nebula and the whole vicinity afford a grand conception of the grandeur and richness . . . and the beauteous gradation and variety of the heavens."

WALTER SCOTT HOUSTON

STARS FOR JULY

from latitudes 30° to 50° north, at 9 p.m. and 8 p.m. local time, on the 7th and 23rd of the month, respectively. The 40° north horizon is a solid circle; the others are circles, too, but dashed in part. For the year 1948, these simplified charts replace our usual white-on-black maps, which may be consulted in issues of prior years when information on deep-sky wonders and less conspicuous constellations is desired. Our regular charts for observers in the Southern Hemisphere appear in alternate issues.



EVENING STARS FOR SOUTHERN OBSERVERS

THIS CHART is prepared for a basic latitude of 30° south, but it may be used conveniently by observers 20 degrees on either side of that parallel. These southern charts appear in alternate months, but always two or three months in advance to allow time for transmission to observers in any part of the world. The sky is here shown as it appears on Sept. 7th at 11 p.m., Sept. 23rd at 10 p.m., Oct. 7th and 23rd at 9 p.m. and 8 p.m. respectively. Times for other days vary similarly, four minutes earlier per day. These are local mean times which must be corrected for standard time differences. The 30° horizon is a solid circle; the other horizons are circles, too, those for 20° and 40° south being dashed in part. When facing south, hold "South" at the bottom, and similarly for other directions. Observers in the tropics may find north circumpolar stars on any of our northern star charts. For other charts in this series, see alternate issues, October, 1946, to August, 1947; and September, 1947, to May, 1948.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